electricity north west

Bringing energy to your door

Annex 11: Climate Resilience Strategy

How we will ensure that our network is resilient to the challenges presented by the changing climate.

December 2021

Contents

1. Introduction

As the Distribution Network Operator for the North West of England, we are responsible for the operation and maintenance of the electricity distribution network serving 2.4 million customers. This network is made up of around 57,000km of overhead line and underground cable, over 500 major substations and numerous smaller items of plant and equipment.

This Climate Resilience Strategy sets out our approach to ensuring that our network is resilient to the challenges presented by a changing climate, so that we can continue to provide a reliable electricity supply to our customers.

As a company we have been pro-active in working with our stakeholders to develop plans to facilitate the move to Net Zero in advance of the targets in the Paris Climate Change Agreement. We set out the role that we will play in our publication "Leading the North West to zero carbon"[1].

However, despite the actions taken by ourselves and many other organisations to mitigate the potential changes in climate, we recognise that the climate will change, and there is a high risk that we will see average temperature increases of 2^{O}C and higher over the next century.

Ensuring that our network is resilient to the consequences of these changes over the long-term requires us to adapt to the likely impacts. These adaptation measures sit alongside the actions we are taking to mitigate our own impacts and enable wider mitigation measures across the region as part of the drive to Net Zero.

As most of our electrical assets will be in service for over forty years we need to ensure that the decisions that we are making now are appropriate to provide a resilient network in the future. This document sets out the history of climate change adaptation within Electricity North West, how we have worked with partners in industry and academia to develop our approach to adaptation, the risks that climate change poses to our network and our forward strategy for managing those risks.

The strategy can be summarised as:

- Address the immediate risk from increased flooding;
- Monitor other known risks;
- Work with industry partners and a range of experts to identify new risks; and
- Act on any changes to the risks we face.

We continue to collaborate with partners, industry colleagues and regional stakeholders to develop our climate resilience approach and welcome any feedback on these plans.

This is an update of our initial strategy published to accompany our RIIO-ED2 Draft Business Plan in July 2021 and we commit to publish updated versions of this strategy on an annual basis through RIIO-ED2.

[1] https://www.enwl.co.uk/globalassets/go-net-zero/net-zero/documents/leading-the-north-west-to-net-zero.pdf

2. What is Climate resilience?

The Centre for Climate and Energy Solutions defines climate resilience as 'the ability to anticipate, prepare for, and respond to hazardous events, trends, or disturbances related to climate. Improving climate resilience involves assessing how climate change will create new, or alter current, climate-related risks, and taking steps to better cope with these risks'[2].

As an electricity distribution company, we need to address the threats that climate change will present to the reliability of our network, so that we minimise the number of interruptions to supply that customers experience as a consequence. To do this we need to understand what the risks posed to our network are.

The National Risk Register[3], developed by the Cabinet Office, captures a broad range of challenges, risks to the safety and security of the UK, including environmental hazards. These include flooding and severe weather, the frequency and impact of which are forecast to increase under future climate scenarios.

The Climate Change Committee commissions an independent assessment of UK Climate risk every five years, called the Climate Change Risk Assessment (CCRA). The latest report, published in June 2021[4] focuses on risks resulting from two climate change scenarios (a 2°C and 4°C risk in global temperature by 2100), and identifies 34 out of 61 risks from climate change in the UK as being 'high' magnitude in a 2°C increase scenario. The report draws out key messages for the energy sector[5], with five of these relating specifically to electricity distribution:

- All energy related infrastructure is at risk from the impacts of climate change, especially due to the changing frequency and intensity of surface water and coastal flooding;
- High and low temperatures, snow and ice, high winds and lightning can all cause disruption to the energy network. The future risks from wind and lightning are more uncertain than for other hazards;
- Energy infrastructure assets represent a key element of the UK infrastructure system and could affect, or be affected by, failures of other assets due to extreme weather such as transport, information and communications technology (ICT) and water infrastructure including reservoirs, pipelines, water treatment plants and sewage treatment plants;
- There are also risks to buried infrastructure such as gas pipelines, with damage potentially becoming more frequent in future due to flooding (affecting bridges that carry pipelines) and subsidence; and
- Household heating demand is very likely to decrease due to warmer winters, and cooling demand is likely to increase in hotter summers if air conditioning uptake increases. These changes may alter the pattern of peak electricity demand for energy companies.

Within the energy sector specific briefing these risks (in the white cells) together with five related risks (shaded in grey in the table) were further classified based on urgency of action required over the next five years, crossing over between our current price control period (RIIO-ED1) into the next price control period (RIIO-ED2):

[2] https://www.c2es.org/content/climate-resilience-overview/
[3] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/952959/6.6920_CO_CCS_s_National_Risk_Register_2020_11-1-21-FINAL.pdf
[4] Independent Assessment of UK Climate Risk - Climate Change Committee (theccc.org.uk)
[5] CCRA3-Briefing-Energy.pdf (ukclimaterisk.org)

Risk ID	Risks to energy sector	Risk assessment
II	Risks to infrastructure networks (water, energy, transport, ICT) from cascading failures	More action needed
I2	Risks to infrastructure services from river, surface water and groundwater flooding	More actions needed
H6	Risks and opportunities from summer and winter household energy demand	More actions needed
I3	Risks to infrastructure services from coastal flooding and erosion	Further Investigation needed
I10	Risks to energy from high and low temperatures, high winds, lightning	Further investigation needed
I4	Risks to bridges and pipelines from flooding and erosion	Further Investigation needed
I6	Risks to hydroelectric generation from low or high river flows	Further Investigation needed
I7	Risks to subterranean and surface infrastructure from subsidence	Further Investigation needed
I9	Risks to energy generation from reduced water availability	Maintain a watching brief
I11	Risks to offshore infrastructure from storms and high waves	Sustain current action

Table 1: Findings from the third UK Climate Change Risk Assessment Evidence Report 2021

The lettering in the 'Risk Id' refers to: "I" - the 'Infrastructure' technical chapter or "H" the 'Health, Communities and Built Environment' technical chapter.

The Climate Change Committee (CCC) risk assessment highlights several risks that are directly relevant to the electricity distribution sector (I1- I10), along with others that are indirectly related. Our Climate resilience strategy focuses on the environmental hazards included in both the National Register and the Climate Change Committee risk assessment report that relate directly to our sector.

The CCC also recently published their progress report[6] to Parliament on adapting to climate change, which they published alongside their annual progress report on reducing emissions. Its strong messages reinforce those of the independent assessment, including:

- Achieving Net Zero will require effective adaptation. Policies (on Net Zero and beyond) that fail to sufficiently recognise climate risks may undermine their goals, lock in climate risks, and store up costs for the future; and
- Since previous CCC reports, there have been some improvements, notably in tackling flooding and water scarcity but overall progress in planning and delivering adaptation is not keeping up with increasing risk.

[6] https://www.theccc.org.uk/publication/2021-progress-report-to-parliament/

3. Ongoing Engagement

Throughout RIIO-ED1 we have continued to work with national and local stakeholders, including the Environment Agency and academic institutions to develop our understanding of the impacts of climate change and adapt our approach.

Nationally, this engagement has mainly taken place through the Energy Networks Association (ENA) and related working groups, combining electricity distribution and transmission, gas distribution and transmission and the Electricity System Operator. As part of this engagement we will be reviewing the recommendations published in the Climate Change Committee's recent risk assessment report to introduce a "common formalised standard of resilience, such as the new ISO 14091 standard, across different infrastructure sectors including the energy sector to help build systemic resilience across the whole infrastructure system."

Regionally, for many years we were active members of the North West Climate Change Adaptation Group (NWCCAG) and worked with local authorities such as the Greater Manchester Combined Authority and Manchester City Council to help develop their adaptation plans. The NWCCAG no longer meets, but we continue to liaise with authorities across our area on a bilateral basis.

Recently, we have taken the lead in engaging with local stakeholders on climate change. In 2019 we initiated a series of decarbonisation pathways projects with local water and gas utilities and the Greater Manchester Combined Authority. We are continuing this engagement to support our future scenarios development as we adapt our forecasts for future load, energy efficiency and decarbonisation in our area. This engagement will also allow us to continually review and adapt our Climate Resilience strategy, enabling us to map out different approaches against different Net Zero scenarios or pathways, and refine as appropriate, following recommendations from the UK Climate Risk Energy Briefing (June 2021).[7]

In RIIO-ED1 we have also set up a Sustainability Advisory Panel who have continued to engage and challenge us on our Climate Change approach which they reviewed in May 2020. We will continue to engage with the advisory panel to ensure that our strategy matches the expectations of our customers and stakeholders.

[7] https://www.ukclimaterisk.org/wp-content/uploads/2021/06/CCRA3-Briefing-Energy.pdf

4. Adapting to a Changing Climate

As a network operator, in order to understand how we need to adapt to an impact of a changing climate, we first need to understand what the impacts might be, at what scale and over what timeframe. This enables us to look at our current equipment and decide what enhancements we need to make to ensure it remains resilient in a changing climate.

4.1 Climate Change Adaptation Reporting

The Climate Change Act 2008 gave the government the power to direct public sector organisations, and statutory undertakers (such as energy and water companies) to report on their assessment of the risks climate change poses to them, and the actions they are going to take in response (the Adaptation Reporting Power).

This has resulted in three rounds of Climate Change Adaptation Reporting, which feed into the government's Climate Change Risk Assessment (CCRA). We have produced two reports in 2011 and 2015, which are available on our website[8], and we are in the process of developing our 2021 report which we will publish in December.

Our approach to the development of each report has followed a similar pattern. We have worked with colleagues from other electricity network companies, through an Energy Networks Association (ENA) working group, to develop an industry-wide assessment of the risks from climate change and the potential mitigation responses, which are published in an ENA Engineering Report. We have then used this document as the basis of our own company-specific response.

The ENA Climate Change Adaptation Reporting Working Group (CCARWG) engaged with experts from the Met Office and academia, and commissioned research projects to understand the changes that we could expect in the climate and the potential impact on our networks.

For the 2021 report, the CCARWG has been expanded to include representatives from the Gas Distribution and Transmission Networks, enabling us to consider the impacts for the Whole System of energy networks.

4.2 The risks of a changing climate on networks

In the 2021 ENA CCARWG Adaption Report, electricity network companies identified the following major risks due to climate change on a national basis:

AR1 Temperature - Overhead line conductors affected by temperature rise

Thermal expansion of conductors in Summer is a common consideration for all overhead lines, and supporting structures are designed to account for sag to ensure the minimum ground to conductor clearances are maintained.

Where these lines are exposed to temperatures considered extreme by UK standards, and where the frequency and duration of these events increases, it is possible that sag will exceed the current overhead line design parameters. This could lead to an increasing number of incidents where conductor clearance limits are compromised.

[8] https://www.enwl.co.uk/about-us/engaging-with-our-stakeholders/stakeholder-engagement-publications/

Increasing temperatures also impact on the capacity of the conductors and of the network as a consequence. Conductors are designed to operate at their maximum efficiency up to a maximum core temperature, and as air temperature increases it becomes difficult for the heat from the conductor to radiate. As the core temperature increases so does resistance within the conductor reducing its ability to carry current, thus reducing its capacity.

AR2 Temperature - Overhead line structures affected by Summer

drought and consequent ground movement Increasing temperatures will, without precipitation, lead to drying of the ground causing it to shrink. Any structures built on this ground will be subject to movement which, as well as being amplified by the height of the structure, can lead to instability of the foundations. Overhead line structures are more vulnerable to this movement, but it can also impact on ground mounted structures such as transformer bases and switch house foundations.

AR3 Temperature / precipitation - Overhead lines affected by interference from vegetation due to prolonged growing season

Increases in both temperature and precipitation will lead to increased vegetation growth. This impacts on overhead lines as increased growth of branches of trees growing adjacent to the overhead lines can impact on minimum clearances leading to faults and physical damage.

AR4 Temperature - Underground cable systems affected by increase in ground temperature

As with overhead lines, increasing temperatures impact on the capacity of cables and of the network as a consequence. Cables are designed to operate at their maximum efficiency up to a maximum core temperature, and as the ground temperature increases it becomes difficult for the heat from the conductor to radiate; as the core temperature increases so does resistance within the conductor reducing its ability to carry current and thus reducing its capacity.

AR5 Temperature - Underground cable systems affected by Summer drought and consequential ground movement

Ground movement caused by drying and shrinkage will exert tensile forces on cables. Whilst cables have an inherent tensile strength, joints in the network are more vulnerable and can fail by being effectively pulled apart. Extreme wet-dry and freeze-thaw ground movements will have a similar impact.

AR6 Temperature - Substation and network earthing systems adversely affected by Summer drought conditions

As moisture in the soil reduces the soil resistivity increases reducing the effectiveness of the earthing system. Where earthing design parameters are exceeded system and public safety issues can arise with reduced touch potential distances or failure to fully dissipate fault current, leaving exposed metal components inside and outside the site boundary live.

AR7 Temperature - Transformers affected by temperature rise

As with cables and overhead conductors, transformers are designed to operate within particular temperature parameters. As air temperature increases it becomes more difficult to expel the heat created by the transformation process, consequently transformers can begin to overheat reducing capacity and life expectancy and, in extreme cases, causing catastrophic failure of the unit.

AR8 Temperature - Transformers affected by urban heat islands and coincident air conditioning demand

Localised build-up of heat, particularly in city environments, will lead to increased demand from air-conditioning and ventilation unit operation; some network operators are now seeing very little difference between Summer and Winter demand where traditionally Summer was always the season of reduced electricity usage. Increased demand can overload transformers causing tripping and loss of supply.

AR9 Temperature - Switchgear affected by temperature rise

Increasing temperature impacts all plant and equipment and increases will impact on switchgear by reducing its capacity, or in extreme cases lead to the switchgear tripping resulting in loss of supply or operating incorrectly and damaging the network. Prolonged periods of hot weather will increase the temperature inside switch rooms above the maximum optimum operating parameter for the switchgear increasing the potential for faults or maloperation.

Although, as with overhead lines, switchgear is designed to international standards, there are recorded days where switch room ambient temperatures have exceeded the operational maximum of the switchgear.

AR10 Precipitation - Substations affected by river (fluvial) flooding due to increased winter rainfall

AR11 Precipitation - Substations affected by pluvial (flash) flooding due to increased rainstorms in Summer and Winter

AR12 Precipitation - Substations affected by sea flooding due to increased rainstorms and/or tidal surges

Regardless of the source the impact of flooding on ground located assets is the same. Plant and equipment is physically damaged by flood water, but water ingress will also cause faulting within the assets and the network leading to extensive loss of supply. Consequential repair or replacement of assets is costly and time-consuming extending restoration of supply to local areas. Network operators will often choose to switch out plant and equipment in order to avoid water ingress causing a fault and uncontrolled shut down.

AR13 Precipitation - Substations affected by water flood wave from dam burst

Where substations are located far enough away from dams the impact of water inundation from a dam burst is no different from “standard” pluvial, fluvial, or tidal flooding and flooding impacts can be considered similar.

Where substations are close enough to dams to be impacted by the full force of a breach, the damage to a substation would be substantial. Plant and equipment would not only be impacted by water ingress but are likely to be physically damaged or even washed away by the force of water. Where a substation site has been impacted by the full force of a dam breach, it would not be possible to re-establish supply without fully reconstructing and recommissioning the site.

AR 14 Overhead lines and transformers affected by increasing lightning activity

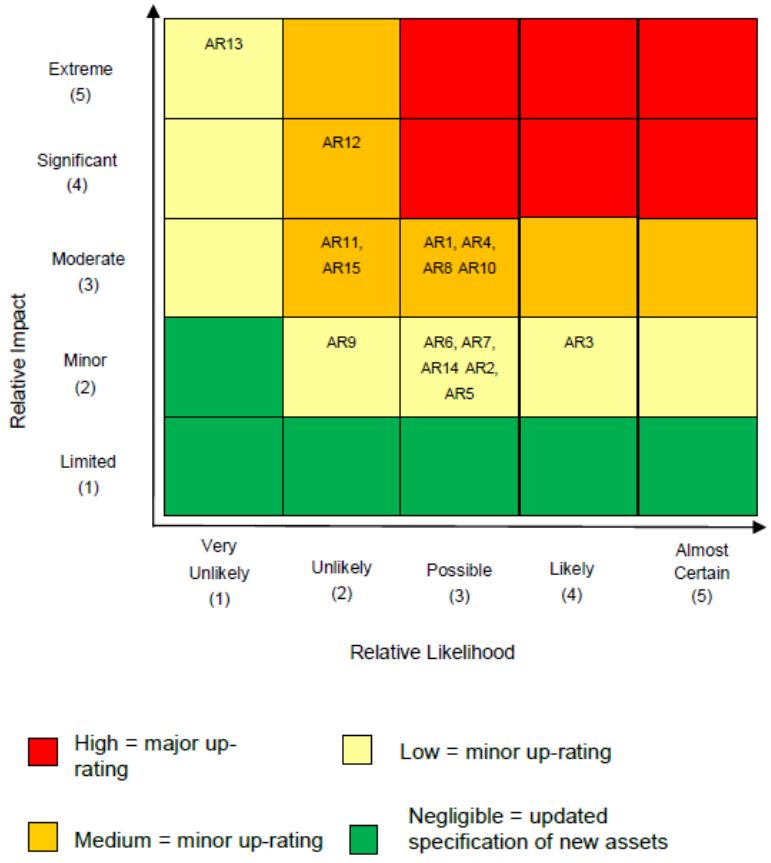
Increased storm frequency can lead to an increased lightning strike frequency. Where lightning strikes exposed substation plant or, more likely, overhead line assets, the resulting surge will cause circuits to trip under fault condition. In extreme cases strikes will lead to physical damage to the assets or a loss of generation, leading to other network protection systems operating and leading to loss of supply.

AR15 Wildfire - Overhead lines and underground cables affected by extreme heat and fire smoke damage

This risk has been added for the third-round reporting following the Saddleworth Moor wildfires in 2018. Although a consequential risk of increased temperatures and reduced precipitation, wildfire poses a significant risk to overhead line structures and conductors where they are located in susceptible areas such as open heathland.

Operational telecommunication systems should also be considered at risk from this scenario, and without operational telecoms it is impossible to control the network and loss of supply could occur following an unrectified fault.

Each of these risks has been scored and the current risk position for electricity is shown below.



The impact and likelihood of these risks will vary across the country and we will consider the specific implications for Electricity North West in our report (to be published in December 2021). Along with our 2011 and 2015 reports, we recognise the following major risks to our network;

- **Flooding** – we expect that the number of flooding incidents will increase, and we are currently acting to protect vulnerable substations from floods.
- **Increase in temperature** – as temperatures increase the performance of our equipment will change. Typically, we expect this to reduce the capacity of the equipment by less than 0.2% per year. We expect demand on our network to increase by up to 2% a year in the long term,

so the climate change adaptation activity will be built into our programme to meet increased load.

- **Increased vegetation growth** – change in climate is expected to lead to an acceleration in the rate that trees grow and extensions to growing seasons, so we will need to modify our inspection and cutting programmes to minimise the interference from trees on our overhead lines.
- **Resilience to more frequent extreme events** – whilst all electricity networks can be vulnerable to lightning and high winds there is currently no evidence to suggest that the intensity of these events will increase in the future, although frequency may increase. A new risk for us is the potential for wild fires, as seen with the fires on Saddleworth Moor and Winter Hill in 2018. We will continue to work with industry experts to monitor research in this area.

4.3 Climate change scenarios

Our assessment was based on the UK Climate Projections produced in 2009 (UKCP09). A new version of the projections was released by the Met Office in 2018 (UKCP18) which updated the forecasts and gave a greater degree of granularity in some areas. They provide projections based on a range of future emission scenarios from those where global emissions of greenhouse gases rapidly decline towards the ambitious climate targets in the Paris Climate Agreement, to those where increased use of fossil fuels lead to higher greenhouse gas emissions. More information on the scenarios from UKCP18 can be found in Appendices A and B.

The ENA CCARWG commissioned a project with the Met Office to understand the differences between the UKCP09 and UKCP18 forecasts and the potential impacts on the energy networks. The project concluded that the assessments based on UKCP09 were still valid for the scenarios provided by UKCP18.

4.4 Current assessment

With the exception of flooding and vegetation growth we expect that the impacts on our business from climate change will be gradual, largely indistinguishable from other factors, and that we will be able to incorporate them into our long-term approach.

Climate Change risk	National Impacts	Regional Impacts
Increase in flooding Including flash flooding, ground water or surface water, river or coastal flooding	Yes	Yes
Increase in temperature Including potential ground movement, asset performance	Yes	Limited
Increase in vegetation growth	Yes	Variable
Extreme events Including lightning activity, high winds, and storms	Yes	Yes

We continue to monitor the other risks identified and will modify our approach over time. For example, we will continually review our vegetation management policy in light of the increase in growth rates and monitor the impact of storm events. This is discussed in our Engineering Justification Paper – 'TREE EJP 1 – Tree Management Programme'.

In contrast to other areas of infrastructure we do not foresee any 'cliff edge' or trigger point where equipment on our network will stop working at reasonably foreseeable temperatures. All our assets are built to national and international specifications, so the types of equipment we use are already seeing service in parts of the world with more 'extreme' climates than our own.

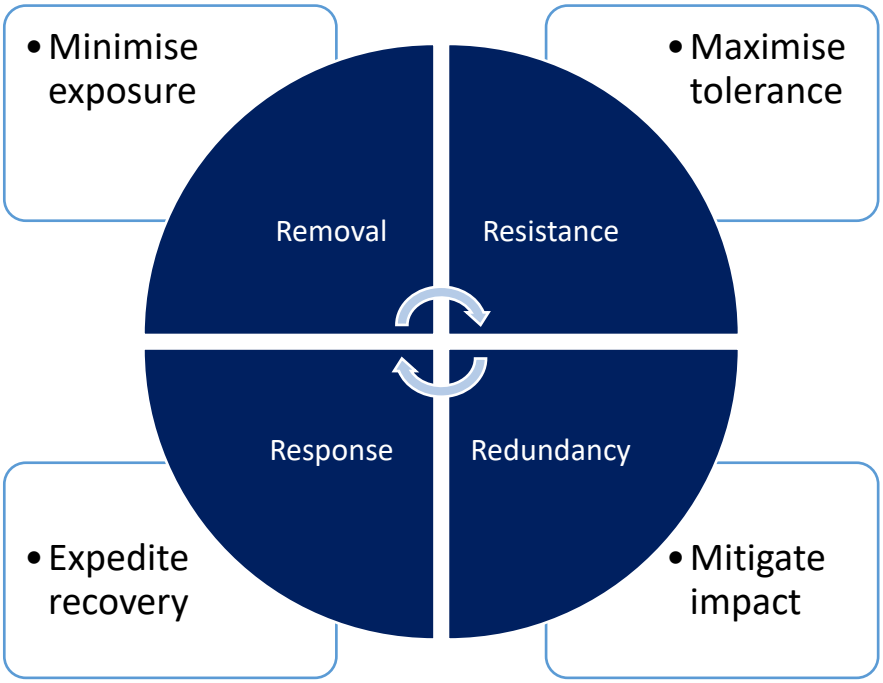
Other distribution companies have chosen to invest in different areas, for example installing taller poles to cater for the potential increase in conductor sag on overhead lines. Using UKCP18, we can compare the mean temperature in our area with that of other parts of the country. Typically, it is 2^{o}C cooler in the North West of England than the south, so we do not expect to see the same problem from conductor sag due to increased temperatures in the near future.

However, we are aware of new risks to our network which we will continue to monitor and assess. These include:

- The increased risk of moorland fires in prolonged periods of dry weather;
- The possibility of earth movement in periods of drought resulting in damage to underground cables; and
- As we move to an increasingly 'smart' network our telecommunications assets will play an increasingly important role in maintaining the flow of electricity. We need to ensure that any assets with long life are resilient to climate change.

5. Our strategy to respond to adaptation risks

Our chosen approach to any resilience challenge can be categorised in a model based around four "Rs" – Removal, Resistance, Redundancy and Response. Each of these addresses a specific aspect of the risk and can be used in conjunction to provide an overall risk mitigation strategy.



The following table gives more detail, using the example of the risk of flooding at a substation to illustrate potential approaches.

Where a threat to the resilience of our network is identified we will assess that threat and choose the appropriate solution/s for the location based on the model above.

The four "R" resilience model	
Approach	**Removal**
Intention	Minimise exposure
Description	Where possible we would reduce our exposure to the risk by making a physical change to the environment.
Example	At a substation we could move the equipment to a new site in an area not at risk of flooding and re-connect the supplies.
Approach	**Resistance**
Intention	Maximise tolerance
Description	Put in place defences against the threat.
Example	We might build a wall around the substation to prevent water getting to the electrical equipment and causing a fault.
Approach	**Redundancy**
Intention	Mitigate impact

Description	Reduce the impact of an outage by providing supplies from an alternative source.
Example	In some locations it may not be possible to build physical defences, but we may be able to build interconnectivity into our network so that if a substation fails, its customers can be supplied from another substation.
Approach	**Response**
Intention	Expedite recovery
Description	Ensure that the resources are in place to recover from the outage as quickly as possible.
Example	We would ensure that we have sufficient trained staff available, with appropriate resources, to deal with potential outages. We would also ensure that we would have access to equipment such as mobile generators to provide an alternative source of electricity.

6. Our RIIO-ED2 Climate Resilience Action Plan

The following summarises the actions we will be taking in the RIIO-ED2 period to refine and implement our climate resilience strategy in light of the risks outlined earlier and the 'four R's' resilience model described in section 5.

6.1 Co-ordinating actions

Our sector already has well-established co-ordination arrangements to respond to major events. This includes liaison through the Energy Networks Association (ENA), collaborative work on co-ordination with other sectors and mutual aid and support arrangements. Where specific risks are identified, we work together to develop and implement the appropriate response through new or revised technical approaches or specifications. In RIIO-ED2, we are seeking to strengthen these co-ordinating actions and to reach out more to other sectors and infrastructure operators who are affected by the same impacts.

In 2021 a Climate Change Resilience Group (CCRG) was established under the auspices of the ENA "to develop an energy industry strategy to assess, manage and mitigate the impact of climate change on electricity network assets and operation".

Whilst the Climate Change Adaptation Reporting Working Group (CCARWG) met for the sole purpose of developing the industry adaptation report, the CCRG will build on this work to develop strategies, review scientific evidence, engage with stakeholders, produce guidance and investigate the introduction of metrics for resilience.

Currently there are no nationally agreed metrics for the resilience of a network. A major focus of the CCRG will be to understand what a meaningful measure would be and how it would be applied. It is possible that this could be an extension of our current Interruptions Incentive Scheme (IIS) which measures and incentivises the reliability of our network. Alternatively, it could be an 'input' led measure, such as the number of major substations protected from the risk of flooding.

Action	Target	Date
Help establish the CCRG as the new multi-sector forum to explore climate risks and resilience responses	An energy networks strategy to assess, manage and mitigate the impact of climate change on network assets and operation.	2023
Better integrate assumptions and impact forecasts from key agencies, eg CCC, NIC	A strategy to deal with the inter-dependencies with other infrastructure providers and other industry partners.	2028

6.2 Network actions

Response to storms is a high priority issue with customers. Section 4.4.2 of our RIIO-ED2 Business Plan sets out the measures we will be taking including enhanced resilience to flood and wind events, together with the roll-out of our innovative LineSight technology which will detect damaged overhead lines more quickly and enable faster and more accurate despatch of repair crews. These actions look at the Redundancy and Resistance aspects of our resilience model.

Flooding

Action	Target	Date
We will deliver our planned programme of enhanced flood resilience at major substations	All sites protected to at least 1/100 flood event level	2028

For further details, see section 4.4.2 (Benefit 19) of our RIIO-ED2 Business Plan submission.

Vegetation management

Action	Target	Date
We will deliver our enhanced vegetation management programme which addresses tree growth rates amongst other issues	A vegetation management programme which continues to deliver compliance with all legal and safety requirements as the growth rate of vegetation increases.	2028

For further details, see section 4.4.2 (Benefit 20) of our RIIO-ED2 Business Plan submission.

Integration into wider investment planning

Action	Target	Date
Keep under review the options for incremental actions to address specific adaptation risks, eg taller poles, higher capacity conductors etc.	An annual review of the evolving climate science and the potential impact on our network, which will inform changes in policy as required.	2023

6.3 Research actions

Our understanding of the impacts of climate change is developing rapidly with advances in forecasting and prediction methods, together with emerging learned experience. We will continue to research the potential impacts of climate change and develop our understanding of its impacts in order for us to develop effective responses.

Action	Target	Date
Development of resilience metric	Work with Ofgem and the energy network community to investigate a suitable resilience metric to be used in the RIIO-ED3 period.	2026
Investigate cascade impacts of failure	Through the ENA working group work with infrastructure providers and other industries to identify the dependencies on our networks.	2028
Research specific impacts of emerging risks, eg soil movement	Monitoring report which identifies evidence of faults and remedial work associated with earth movement.	2028

Interaction with our Innovation programme	Where appropriate, progress research projects into resilience impacts through our NIA and BAU innovation programmes.	2028

6.4 Capability actions

In addition to network and research actions, we will look to deepen our co-operation and collaboration with other stakeholders in order to ensure an effective and joined up response to the events that do happen, at whatever scale. These actions are aligned with the Response element of our Resilience model.

Action	Target	Date
We will continue to participate in and develop the industry's co-ordinating arrangements for dealing with major emergencies through the ENA.	Continue to be an active member of all the ENA Resilience Working Groups.	Ongoing
Active membership of Local Resilience Forums (LRF)	Continue to be an active member of all relevant LRF in our area, establishing protocols to use during major outages and participating in preparedness exercises.	Ongoing
Develop our forecasting to include impact of climate change	Review all relevant forecasting methodologies to ensure that the impact of climate change is treated appropriately.	2024

7. Summary

Climate change is happening and will affect the performance of our network. The extent of that impact will be governed by the success of the current global efforts to reduce greenhouse emissions and our ability to adapt our network to cope with the weather-related consequences.

We have used a range of climate change scenarios from UKCP18 to assess the risks to electricity networks and identified that the immediate priority is to reduce the risk to our network from flooding. Our RIIO-ED2 submission includes a comprehensive proposal to address our remaining sites identified as subject to significant flood risk, building on our work in this area over the last 15 years.

As part of our climate resilience action plan, we will continue to monitor and assess other known risks and will take action at the appropriate time. As part of this, we will work with partners in the networks companies, infrastructure companies, government, academia and other experts to assess new and changing risks. This risk assessment will include consideration of cascade or 'knock on' impacts on other sectors.

Where risks are identified we will identify and apply an appropriate solution for that risk and location.

As our understanding of the adaptation risk and its impacts is developing rapidly, we commit to keeping this strategy under annual review so that we can continue to refine our climate resilience approach.

8. Appendix A – UK Climate Projections 18

8.1 UKCP18

United Kingdom Climate Projections 2018 (UKCP18) is the latest release in a series of climate range projection produced by the Met Office as part of the UK Climate Impacts Programme (UKCIP).

The projections provide a range of different outcomes based on differing Representative Concentration Pathways (RCPs) out to 2100.

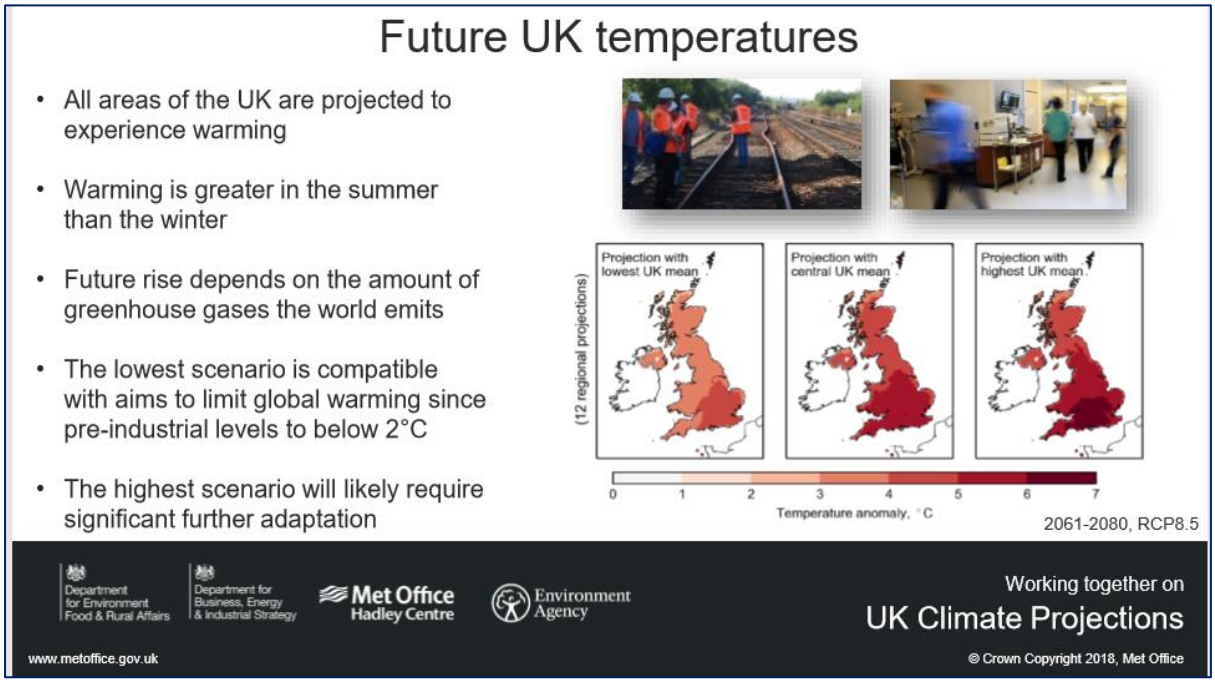
The RCPs represent different assumptions of economic, social and physical changes to the environment through the concentration of greenhouse gases.

8.2 National picture

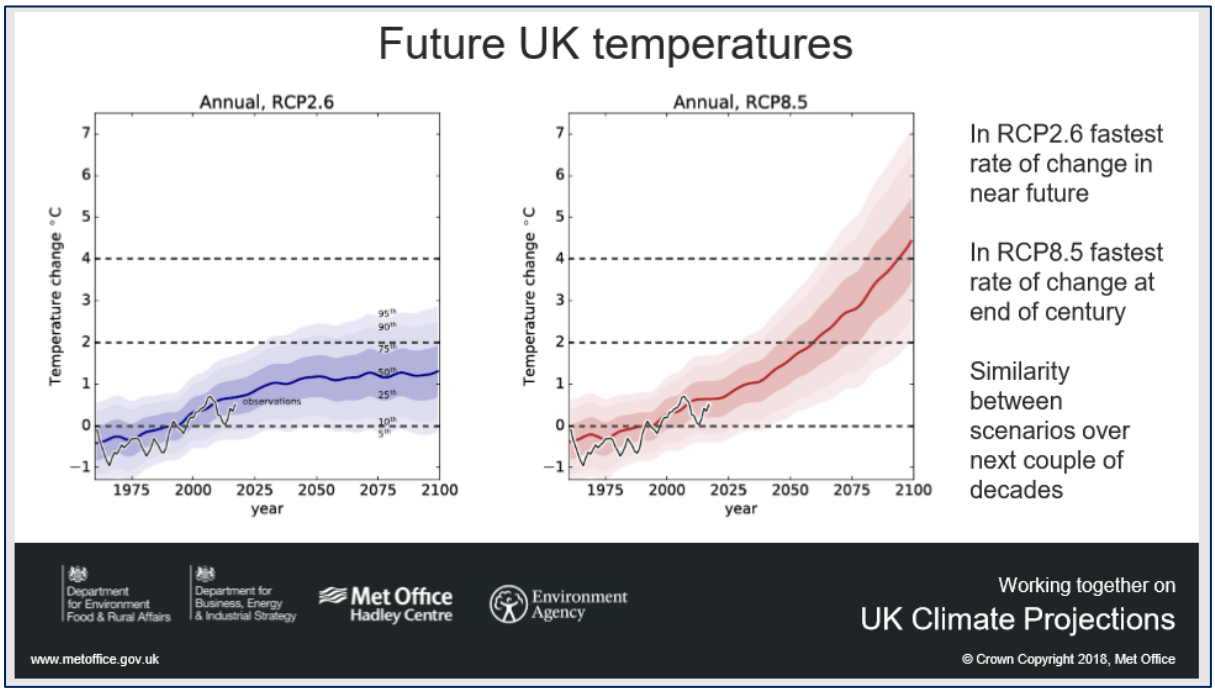
The following overview is taken from the Met Office briefing used at the launch of UKCP18 and shows some of the national headlines.

The overall message is consistent with the output of UKCP09 which we used for our initial modelling.

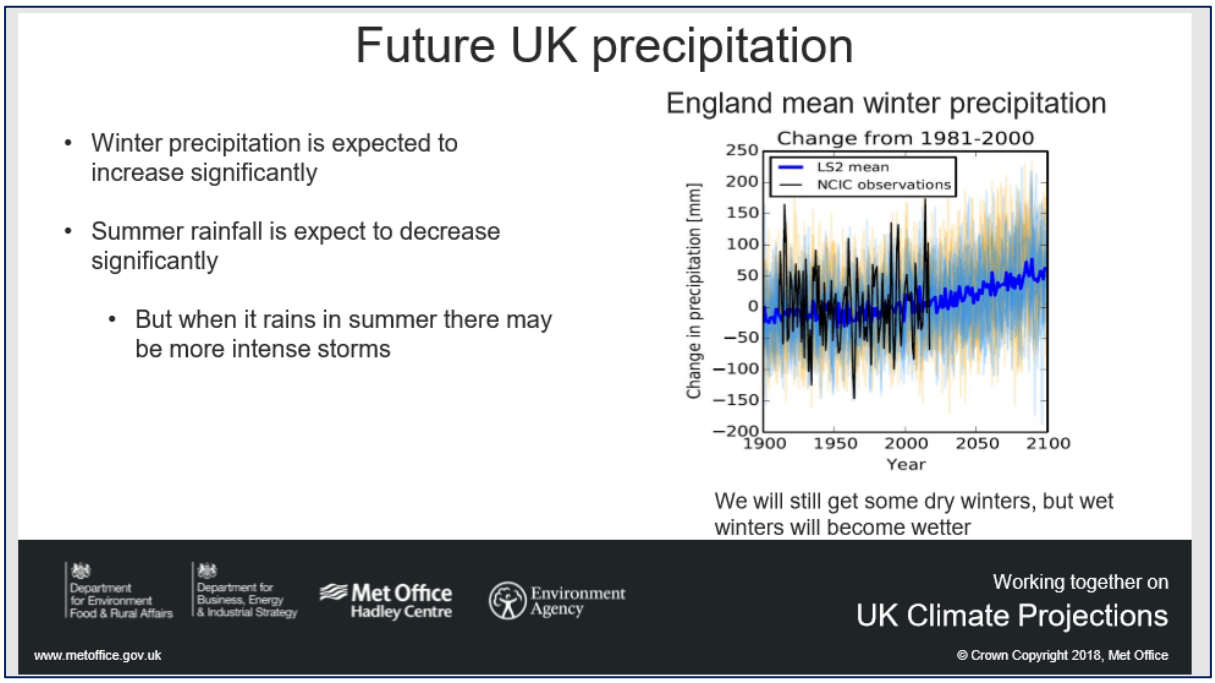
Although there is uncertainty about actual outcomes, all scenarios show a significant increase in temperatures, but the impact is different across the UK with lower temperature increases expected in the north west of England compared to the south.



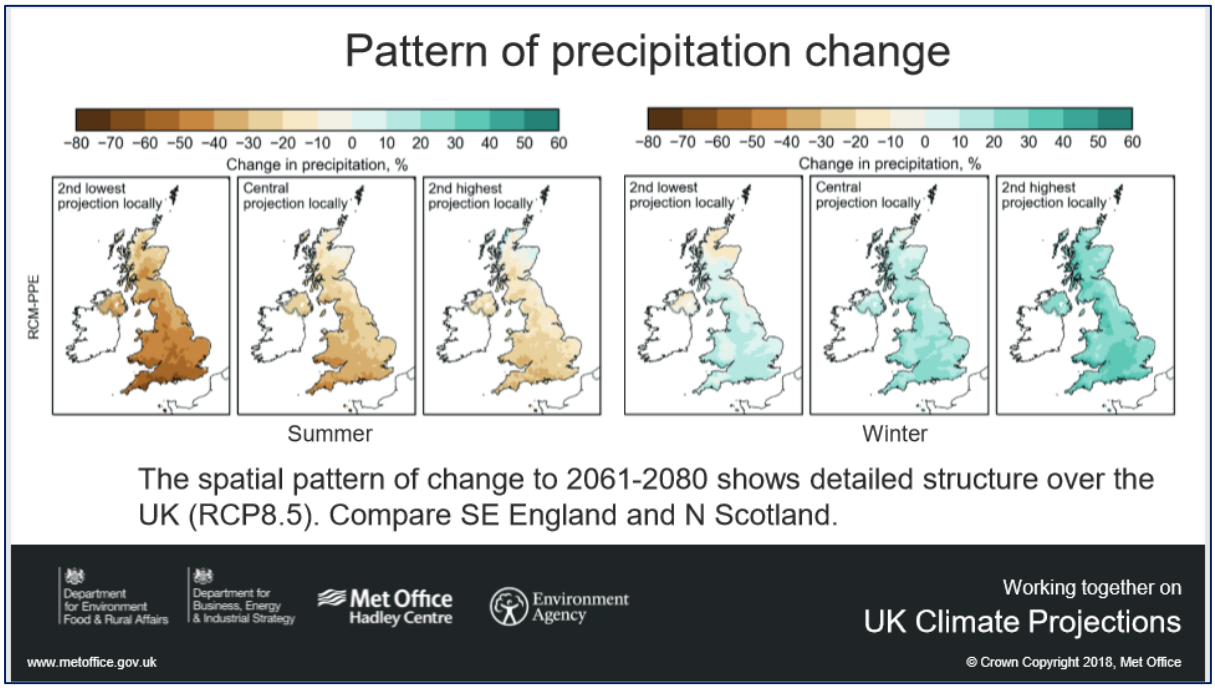
The range of potential outcomes by the end of the century is large, but all scenarios show a similar growth in the next twenty years.



A significant rise in the expected winter rainfall and the increase in intensity of summer storms reinforces our strategy to protect our assets from the risk of flooding.



The range of outcomes for rainfall are more diverse geographically, with the west of the UK seeing greater variability.



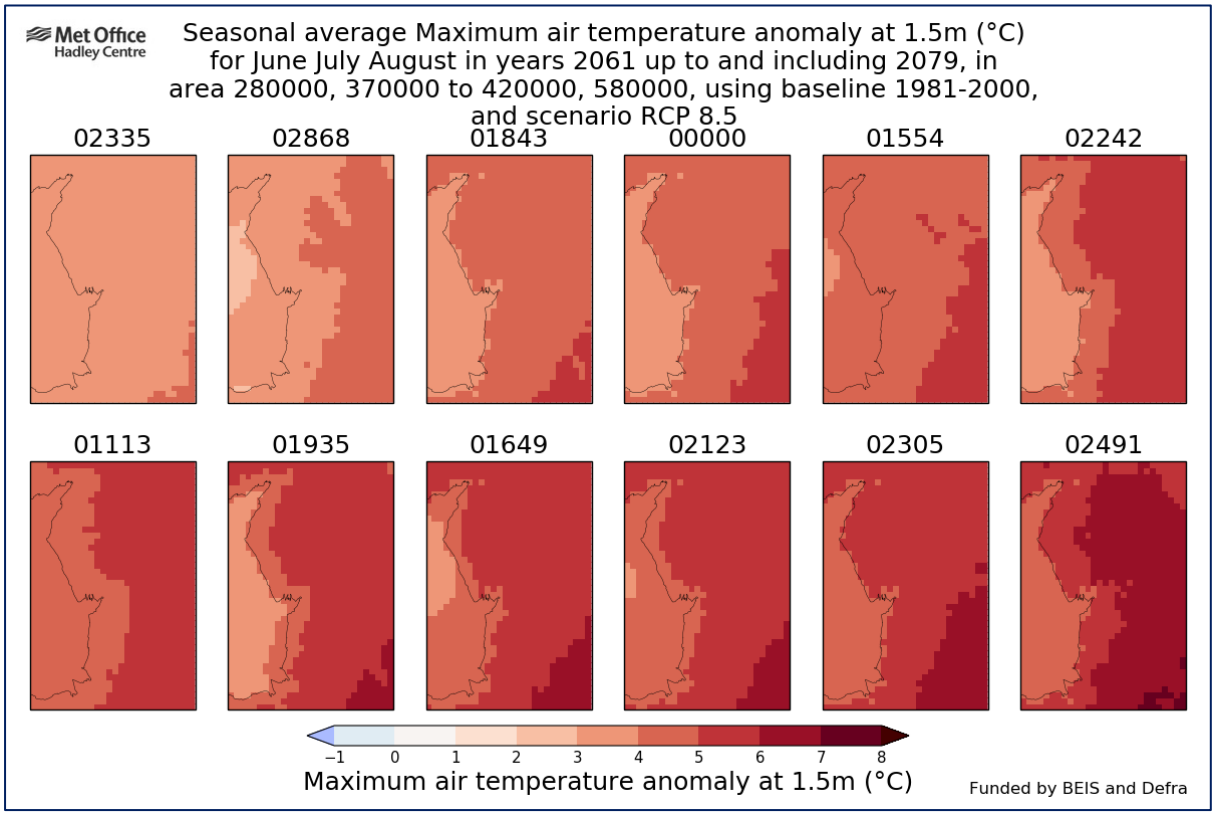
9. Appendix B – Results for the North West of England

UK Climate Projections User Interface

The Met Office have provided a User Interface so that users can access the detailed projections and tailor queries to their individual needs.[9] Using this tool, we have produced a number of charts identifying the potential range of changes in our area. These feed into our detailed investment modelling where appropriate, for example assessing future flooding risk at substations over different time horizons. Some examples are given below.

Change in summer temperature

This chart shows the range of projected change in summer maximum air temperature under a range of scenarios for the period from 2061 to 2079.



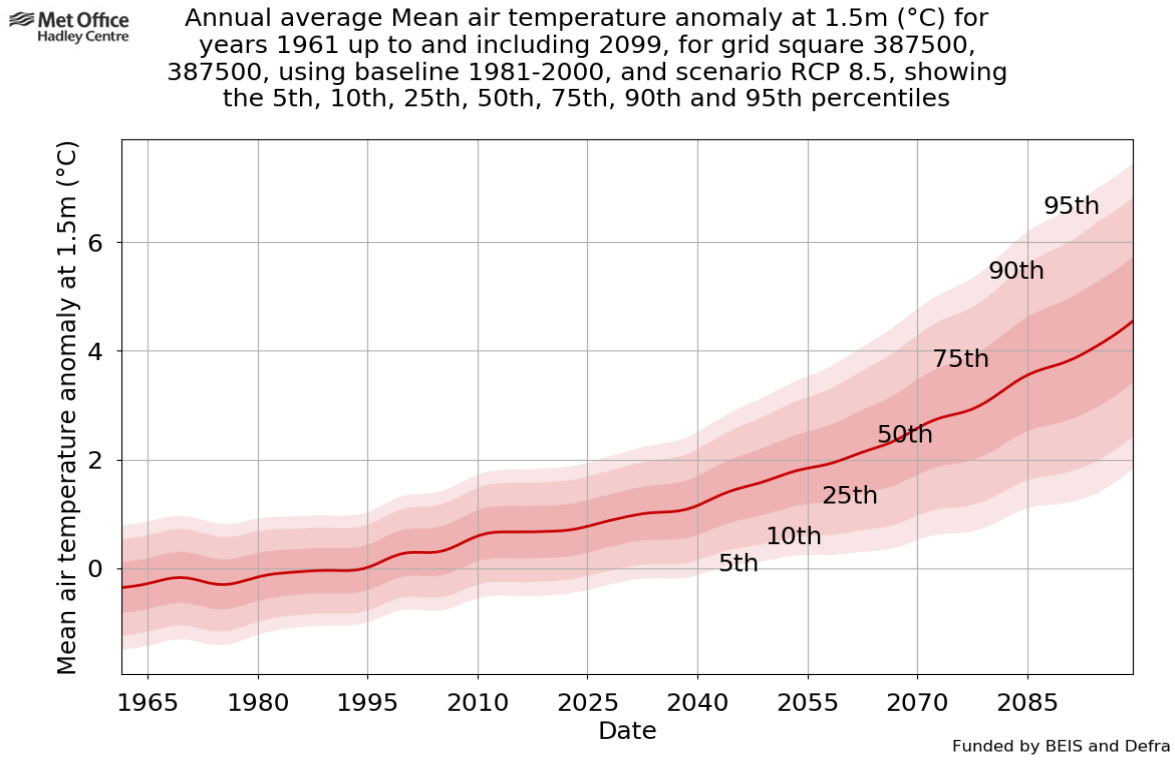
It can be seen that for all scenarios we expect to see an increase of at least 2°C, with scenarios of up to 6°C for some part of our region.

The charts show that generally speaking we would expect to see the more extreme increases to the east and south of or region.

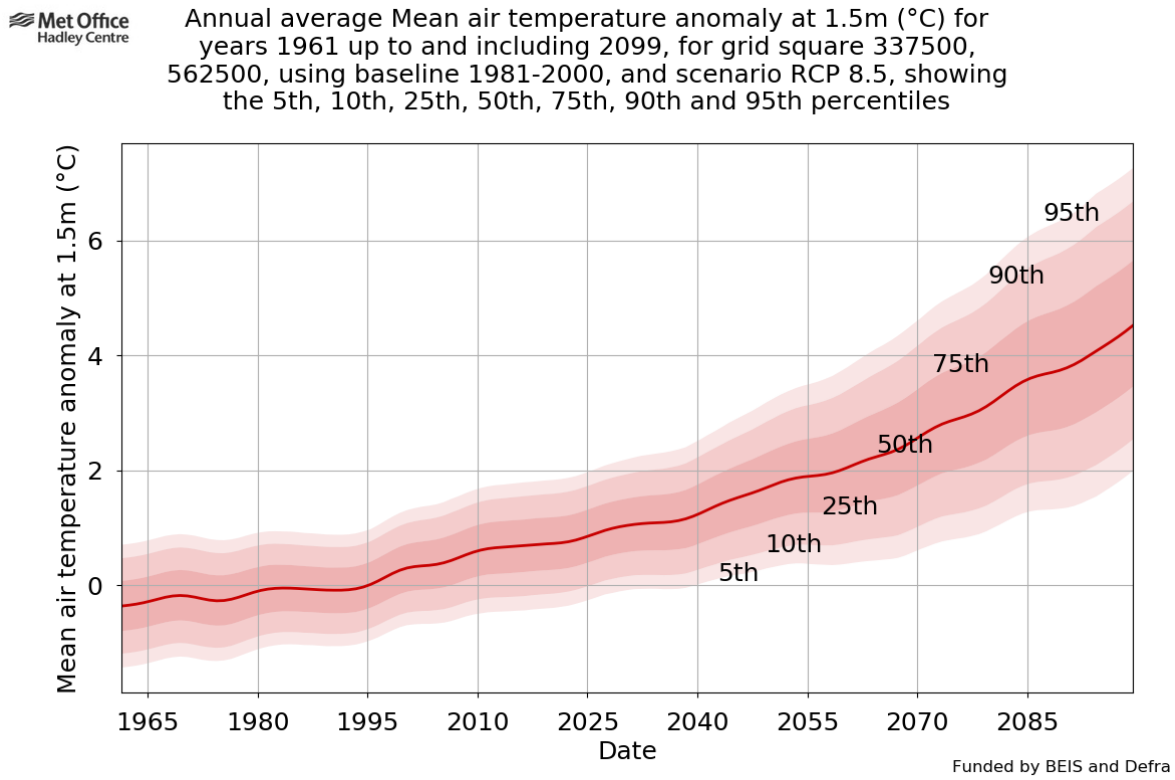
Plume charts for average temperature

[9] https://ukclimateprojections-ui.metoffice.gov.uk/ui/home

We can look at projections for specific areas in our region showing the difference in expected changes. The following plume charts show the projected change in Mean Air Temperature for Manchester in the south of our region and Carlisle in the north. We can see that for this particular measure the increase in average air temperature is very similar.



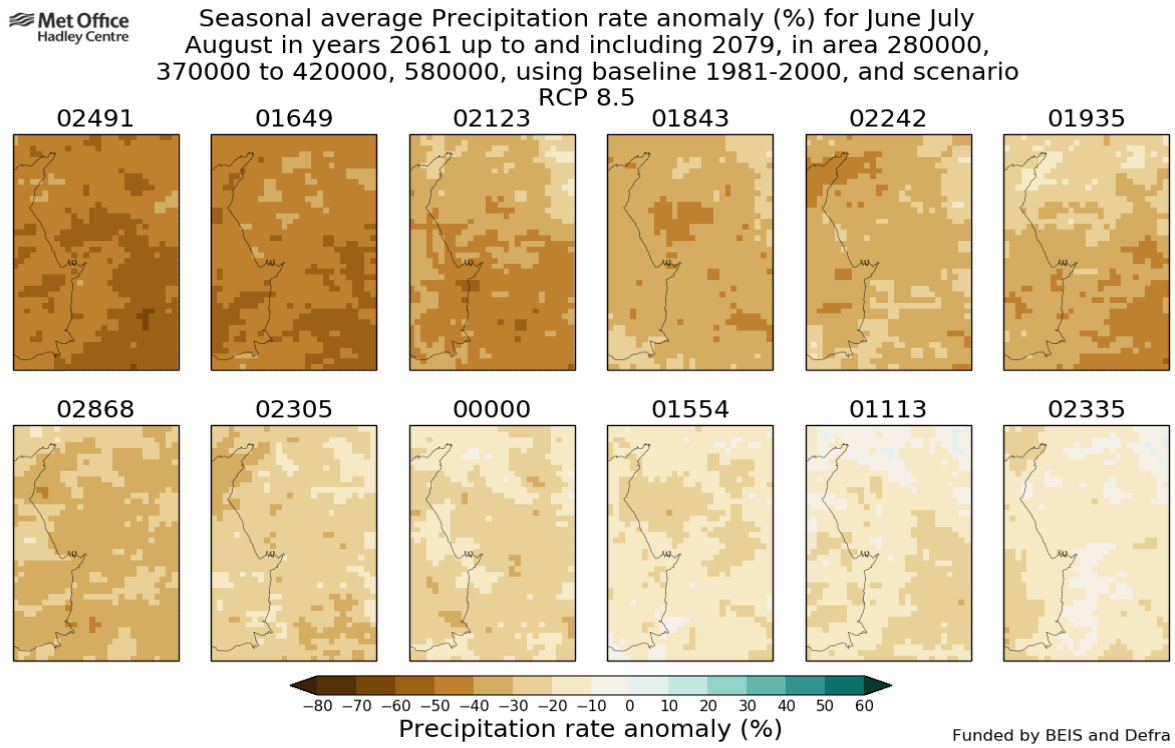
Manchester Plume Chart



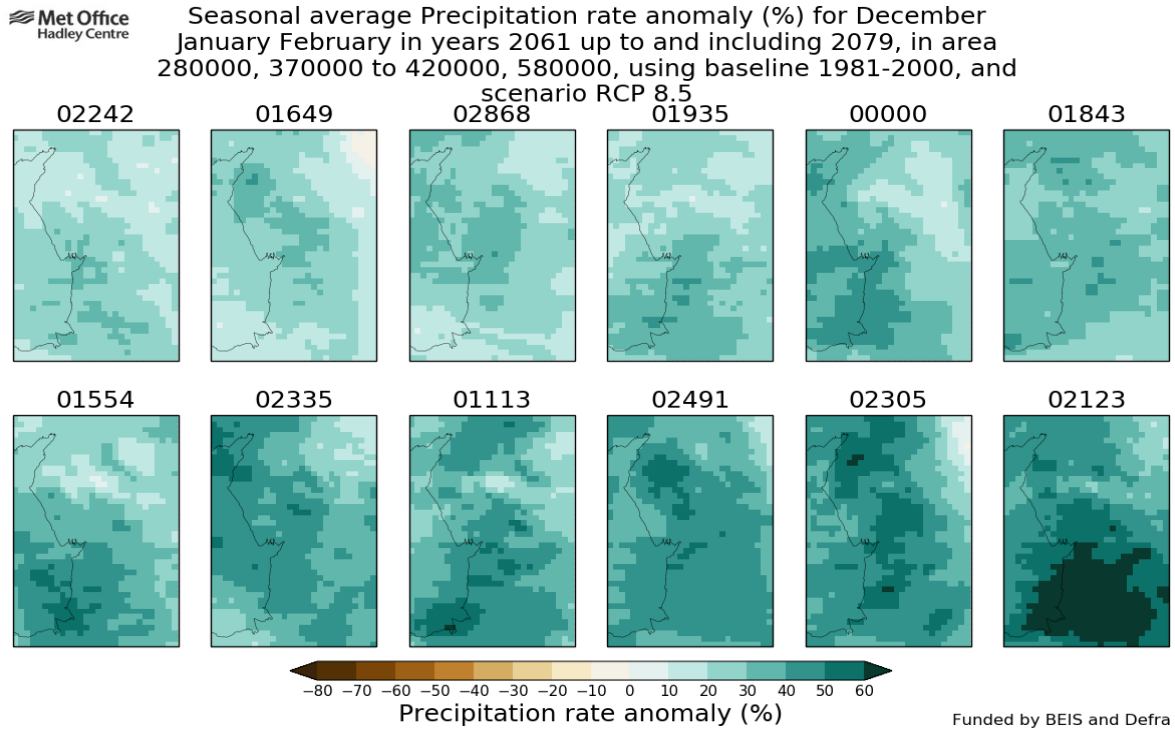
Carlisle Plume Chart

Average rainfall

The following charts show the range of projected change in average rainfall under a range of scenarios for the period from 2061 to 2079 for summer and then for winter. This shows a range of outcomes for average summer rainfall from little or no change (02335) to reductions of up to 60% (02491).



The picture for winter shows the opposite trend with ranges from little or no change (02242) to increases of over 60% (02123).



10. Appendix C - Glossary

Acronyms used in this document:

BAU	Business as usual
CCARWG	ENA Climate Change Adaptation Reporting Working Group
CCC	Climate Change Committee
CCRA	Climate Change Risk Assessment
CCRG	ENA Climate Change Resilience Group
ENA	Energy Networks Association
GMCA	Greater Manchester Combined Authority
LRF	Local Resilience Forums
NIA	Network Innovation Allowance - funding for research and development
NIC	Network Innovation Competition - funding for large scale research and development projects
NIC	National Infrastructure Commission
NWCCAG	North West Climate Change Adaptation Group
RCP	Representative Concentration Pathways
RIIO	Framework for energy network price reviews (Revenue = Incentives + Innovation + Outputs)
RIIO-ED1	First electricity distribution price review under the RIIO framework
RIIO-ED2	Second electricity distribution price review under the RIIO framework
UKCP09	United Kingdom Climate Projections published in 2009
UKCP18	United Kingdom Climate Projections published in 2018