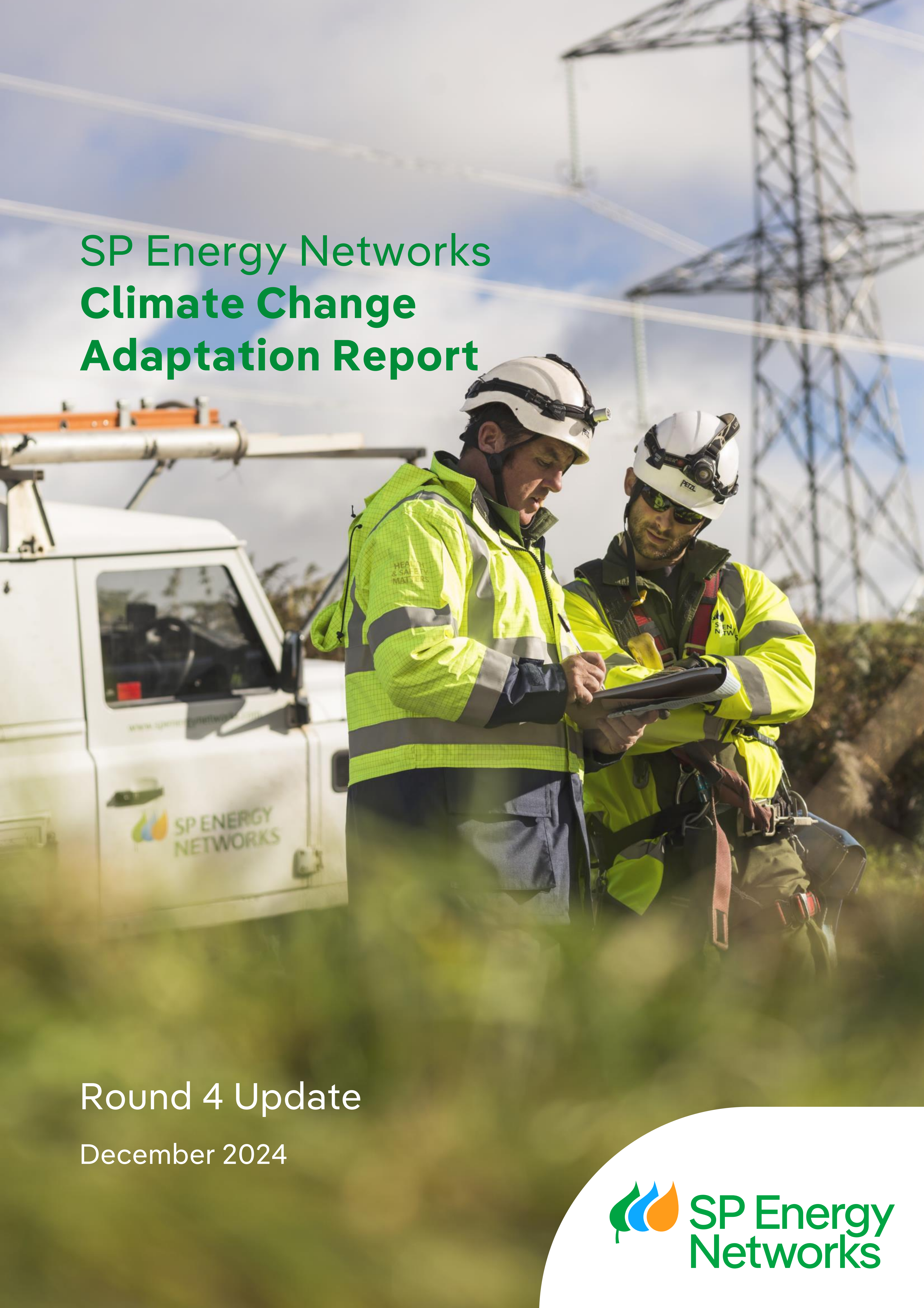
SP Energy Networks
Climate Change Adaptation Report



Round 4 Update

December 2024

SP Energy Networks

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1. Executive Summary

The UK Climate Change Act (2008) gave the Secretary of State for the Department for Environment, Food, Agriculture and Rural Affairs (DEFRA) the power to require companies to report on their preparedness for climate change, under the Adaptation Reporting Power (ARP). The Adaptation Reporting Power was first exercised in 2010, when the Secretary of State required companies responsible for infrastructure and other essential services, including power distribution and transmission companies, to report on their preparedness to adapt to the impacts of climate change.

SP Energy Networks (SPEN) published our first-round response under the ARP in 2011[1], our second in 2015[2], and our third and most recent version in December 2021[3]. In light of a further invitation from the Secretary of State in December 2023, this report captures our fourth-round update to DEFRA, including an assessment of:

- The current and future predicted effects of climate change on our organisation - this includes how we have identified and assessed the risks to our network & business from climate change.
- Our proposals for adapting to climate change - this includes how we have identified the resulting optimal actions & mitigation plan to the threats from climate change.

As the provider of a critical national infrastructure, we have an obligation to ensure the electricity we distribute to our customers is safe, reliable, efficient, and sustainable. This report sets out how we have assessed the threats to our infrastructure from climate change, and the future mitigating actions we may need take in response to these threats. However, as an electricity network operator serving over 3.52m GB customers, we also have a critical role in enabling the UK's journey to Net Zero, and in limiting the effects of Climate Change.

We are enabling our customers to lead the global Net Zero transition by facilitating our communities to connect up to 1.8m electric vehicles, 1.1m heat pumps and up to an additional 7.5GW of distributed generation (around 90% of which is derived from renewable and storage solutions) by the end of this decade. More details on our plans to invest in our networks to enable this transition can be found in our RIIO-ED2[4] and RIIO-T3[5] business plans.

Our Climate Risk Assessment

As per the consultation on plans for the fourth round reporting, and the reduced time period between ARP3 & ARP4 reporting, this round is a light touch update. We have followed the reporting guidance, issued by DEFRA, and no new climate data projections have been included within our ARP4 risk assessment, rather we have built on our ARP3 risk assessment template to better understand our climate risk. However, the most up to date climate projections from the UK Met Office UKCP data has been included within section 4. We assessed the risks from climate change to our network[6] and to our business[7] using global best practice. We did this across four key climate change projection variables (temperature, precipitation, sea level rise, and wind speed/storminess) over three time periods (2030s, 2050s, and 2100s) and the Representative Concentration Pathways (RCP) projection scenarios[8] RCP8.5. The information for which was sourced from the United Kingdom Climate Projections 2018 (UKCP18) data[9].

This approach allowed us to consider risks to our network within our fourth-round update, such as the impact of increased air conditioning electrical loading in summer periods. This could lead to overloads of system

[1] http://archive.defra.gov.uk/environment/climate/documents/adapt-reports/04distribute-trans/sp-energy-networks.pdf
[2] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/479266/clim-adrep-sp-energy-networks-2015.pdf
[3] https://www.spenergynetworks.co.uk/userfiles/file/ClimateChangeAdaptationReport_3rdRoundUpdate_FinalIssue.pdf
[4] https://www.spenergynetworks.co.uk/pages/our_riio_ed2_business_plan.aspx
[5] https://www.spenergynetworks.co.uk/pages/riio_t3_business_plan.aspx
[6] Network risks are primarily direct risks to network infrastructure (e.g. substation flooding).
[7] Business risks are primarily risks to business operation (e.g. delayed (non-)operational tasks due to heatwaves).
[8] Climate change projection scenarios have been established based on two Representative Concentration Pathways (RCP).
[9] https://www.metoffice.gov.uk/research/approach/collaboration/ukcp/index

assets or low-hanging conductors for equipment which is typically has a lower electrical rating in summer periods (AR1). We have also built on past work, such as our 2021 Climate Change Adaptation Report[10] and the Energy Network Association (ENA) 2024 4th round climate change adaptation report and Addendum[11].

This has been further validated through external stakeholder engagement and workshops held with internal colleagues.

In order to determine the significance of each risk to our network and to our business, we considered the relative likelihood and impact for each risk for RCP8.5 projection scenarios only as this is the worst case scenario, categorising each risk into 'Very High, 'High, 'Medium' or 'Low' risk. Examples of 'Very High' or 'High' risks identified include:

- Increased Temperature: Overhead line conductors affected by temperature rise and increased cooling demand, reducing rating and ground clearance (AR1)
- Fluvial and Pluvial Flooding: Substations affected by river flooding due to increased winter rainfall, with loss or inability to function leading to reduced security of supply. (AR10)
- Summer Drought: dry-out of soil surrounding underground cables will lead to increased thermal resistivity, reduced heat transfer, and a reduced current (load) carrying capacity (AR16)
- Hurricanes & High Winds: Overhead line structures affected by wind speeds not accommodated for in design.

For each risk, we identified their adaptation tipping points (i.e. when will network or business functions will be compromised, and so when we need to implement our adaptation strategy).

Our Climate Adaptation Pathways

There may be several different solutions to any one risk. Each solution may have different costs, be suitable for different thresholds and be applicable at different points in time. In order to allow future decision makers flexibility, a global best-practice adaptation pathways approach has been adopted, providing solution pathways which help identify the best sequence of actions for different assets. For example, to mitigate the impact of higher temperatures on substations, we should adopt passive cooling solutions early; however, we may ultimately need to use forced-cooling or nature-based solutions such as vegetation to provide shade.

Adaptation pathway diagrams have been developed to demonstrate the route we should adopt for identified hazards and associated risks to adapt our network and business operations. These can be seen in section 8.

Our Contribution to Cross-Sector Work

A reliable and resilient electric power supply is a key enabler of the decarbonisation and adaptation efforts of other sectors which will require a significant amount of electrification, in order to meet the legally binding Net Zero carbon emission targets of UK Governments.

Therefore, it is important to understand the interdependencies between the electric power sector and other critical infrastructure sectors such as water, oil and gas, telecommunications, and transportation. Like other Distribution Network Operators (DNOs) and the Transmission Network Operators (TNOs), we will continue to work to ensure that the UK electricity network remains one of the most reliable networks in the world and that climate change is one of the impacts considered when developing and reinforcing those networks.

Ongoing Monitoring and Evaluation

As part of our approach, we will continue with our framework for Monitoring and Evaluation (M&E) to ensure that the key climate risks are regularly reviewed, and current adaptation approaches are sufficient to mitigate potential impacts. We have outlined a number of roles for internal appointment within our business, including a 'Resilience Coordinator', and 'Resilience Champions' to be responsible for implementing the M&E process.

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[10] SP Energy Networks. (2015). Climate Change Adaptation Report, Round 2 Update. [Accessed 3rd May 2021]. Available from: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/479266/clim-adrep-sp-energy-networks-2015.pdf

[11] Included in full within Annex A of this report.

Why we need to act and the importance of the Adaptation Reporting Power

Network utilisation is forecast to be stressed beyond the original design capacity of the network. Complexity of network operation is increasing significantly as we rely on flexibility, Distribution System Operator (DSO) constraint management and innovation for real-time advanced network management. The criticality of our assets is rising as customers transition to Net Zero and connect greater numbers of electric vehicles and heat pumps. Meanwhile, all of this is set against the background of the climate emergency and increased external threats from rising sea-levels, rising temperatures, changing precipitation and unpredictable severe weather.

Our commitment to assessing, managing, and mitigating the effects of climate change is essential to the asset management of our critical national infrastructure. This report, produced under DEFRAs ARP, helps to ensure that providers of essential services and national infrastructure have embedded climate resilience into the management and operation of their equipment and businesses.

2. Introduction and Background to Report

SP Energy Networks (SPEN) is the group within Scottish Power (SP) which incorporates three licence holders: SP Transmission plc; SP Distribution plc; and SP Manweb plc. This Adaptation Report has been prepared for all of the operations within SP Energy Networks and hence jointly responds to the Directions received by the three separate licence holders regarding reporting under the Adaptation Reporting Power (ARP). Consideration has been given throughout the assessment to the differences between each part of the overall business.

The following key sources are used as the basis of this report:

The Energy Networks Association (ENA) "4th Round Climate Change Adaption Report and Addendum (Dec 2024)" industry wide response to the 4th Adaptation reporting round.

The ENA is the industry body for UK "wires and pipes" companies which carry electricity and gas to UK homes and businesses.

The ENA and its member companies (including SP Energy Networks) have contributed to all rounds of climate change adaption reporting as follows:

- In the first-round adaption report, the response was established as a collaborative project amongst electricity network operators and identified key risks to network assets and operation posed by climate change impacts.
- In the second-round adaption report, we collectively built on our understanding of the risks and updated the Department for Environmental, Food and Rural Affairs (DEFRA) on industry mitigation measures being put into place on the networks. A consistent reporting methodology was developed, and further evidence was provided of actions taken in response to key climate risks,
- In the third-round adaption report, the aim was to provide an update on existing risks, mitigation measures and programmes, and also look to identify any new risks materialising. This third-round report also consolidated Gas and Electricity network reports to provide an Energy Industry response.
- In the fourth-round adaptation report, due to the short window between round three and round four reporting the aim was to provide an update as to the position of the established risks reported within round three with no new climate data to be introduced. This will be the final joint report issued for both Electricity and Gas network operators.
- SP Energy Networks has been involved throughout the development of these industry-wide responses and hence the fourth-round report[12] [13]has been taken as a suitable baseline for this report, with detail added in addition to the ENA baseline regarding the specific characteristics and circumstances of SPEN, and our future Climate Change Resilience Strategy as we look towards to RIIO-3 and beyond;

The SP Energy Networks "Climate Change Adaptation report – Round 2 Update" (June 2015).

This report articulates the progress made following the previous round 1 update, with identification of the key risks to our network and proposed actions.

The SP Energy Networks "Climate Change Adaptation report – Round 3 Update" (December 2021).

This report articulates the progress made following the previous round 2 update, with identification of the key risks to our network and proposed actions.

[12] ENA's Electricity Networks Climate Change Task Group, 4th Round Climate Change Adaptation Report, December 2024: https://www.energynetworks.org/assets/images/Publications/2024/241218ccar4-report-.pdf?1734688336
[13] ENA's Electricity Networks Climate Change Task Group, 4th Round Climate Change Adaptation Report, December 2024 Annex 2: https://view.officeapps.live.com/op/view.aspx?src=https%3A%2F%2Fwww.energynetworks.org%2Fassets%2Fimages%2FPublications%2F2024%2F241218adaptation-reporting-power-4-(arp4)-annex-2-risk-assessment.xlsx%3F1734688348&wdOrigin=BROWSELINK

The SP Energy Networks "Climate Resilience Strategy" for both RIIO-ED2 Business Plan (Issue 2, December 2021)[14] & RIIO-T3 Business Plan (December 2024)[15].

As part of the development of our RIIO-ED2 & RIIO-T3 business plans, we have developed separate a Climate Resilience Strategy. These strategies have built upon all the previous work above, with the additional introduction of "Adaption Pathways" that allow evaluation of both the changing situation with regards to climate change and the identification and timing of new actions that must be taken.

The United Kingdom Climate Projections 2009 (UKCP09) for the UK underpinned the assessment of risks under the first round Climate Change Adaptation report and continued to underpin them in the second report. The third and fourth-round reports have been updated using United Kingdom Climate Projections 2018 (UKCP18).

2.1 Information on our organisation

SP Energy Networks constructs, maintains and repairs the electrical equipment and network assets that transport electricity to around 3.52 million homes and business in the south and central belt of Scotland, and north Berwickshire, Cheshire, Merseyside and North Wales (see Figure 1). The assets, transmission and distribution licences are owned by three wholly owned subsidiaries:

- SP Transmission plc (SPT);
- SP Distribution plc (SPD); and
- SP Manweb plc (SPM).

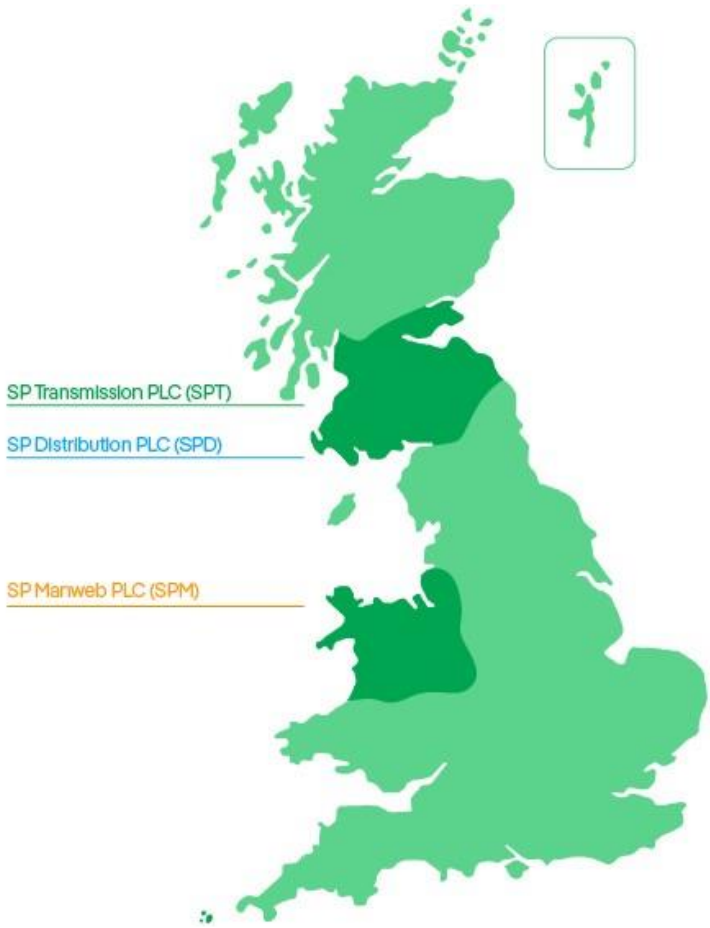

Figure 1 SP Energy Networks Transmission and Distribution Licences

[14] https://www.spenergynetworks.co.uk/userfiles/file/Annex%204A.7%20-%20Climate%20Resilience%20Strategy.pdf
[15] https://www.spenergynetworks.co.uk/userfiles/file/Climate-Resilience-Strategy-RIIO-T3-Business-plan-SP-Energy-Networks.pdf

SP Energy Networks operate in a regulated environment where their regulator, Ofgem, sets targets typically covering a five-year period. SP Energy Networks undertakes the statutory obligations and day-to-day management of the three individual networks with the aim of delivering regulatory targets and implementing an investment strategy to upgrade and reinforce the network. This Adaptation Report is for all of the network assets of SP Energy Networks.

SP Energy Networks is responsible for restoring supply as quickly as possible should a fault occur on the network, providing new connections to the network and maintaining the performance and safe condition of the network. Key drivers for the business are:

- The health & safety of SP Energy Networks employees, contractors, and the public;
- Maintaining security of supply;
- Improving customer service;
- Delivering capital investment to modernise the network and connect new customers; and
- Delivery of the Energy Policy.

Climate change therefore has the potential to impact on a number of the drivers for the business and hence climate risks are recognised as being relevant to the design, construction, operation, and maintenance of networks.

SPM, SPT and SPD are regulated businesses and operate under licences issued by Ofgem. They are subject to a common regulatory framework set by Ofgem and the statutory requirements set by the Electricity Act and Electricity Safety Quality and Continuity Regulations (ESQCR) which are overseen by the Department of Energy and Climate Change (DECC) and the Health and Safety Executive (HSE). As a consequence of these common drivers, UK electricity network operators have worked together for many years across a wide range of activity including:

Establishment of common equipment specifications and design standards, across the full spectrum of network assets, to reduce procurement costs and ensure availability of product;

Establishing UK network owner input to the content, development, and modification to national and international standards - British Standards (BS), European Standards (EN), International Electrotechnical Commission (IEC) etc.;

Providing a unified input to UK government, regulators (Ofgem, Health and Safety Executive (HSE), etc.) on development of regulations, processes, reporting, etc.; and

Collaboration on research and development (including impacts of climate change) and work on asset designs/ ratings.

This basis of a common industry background, asset standards and regulatory processes means that UK electricity network operators have very similar requirements when approaching the assessment of climate change impacts on their networks. This has meant that the ENA has been able to produce a core assessment for all of the UK transmission and distribution companies.

2.2 Background and obligation to report

The UK Climate Change Act 2008 set the UK target to reduce greenhouse gas emissions by at least 100% by 2050[16], from the 1990 baseline. The Act also gave the Secretary of State the power to require companies to report on their preparedness for climate change, under the Adaptation Reporting Power.

The Adaptation Reporting Power was first exercised in 2010, when the Secretary of State required a number of companies responsible for infrastructure and other essential services, including distribution and transmission companies and others in the power sector, to report on their preparedness to adapt to impacts of climate change.

[16] Updated from 80% in June 2019: https://www.legislation.gov.uk/ukpga/2008/27/contents

In December 2023, following on from the first three rounds of Adaptation Reporting Powers, the Secretary of State invited companies which had submitted reports under the previous rounds to submit an update on their levels of preparedness for climate change. Primarily this is to cover the following:

- The current and future predicted effects of climate change on our organisation
- Our proposals for adapting to climate change

The ENA has again coordinated an industry-wide response[17] [18]on behalf of all its members, and SP Energy Networks have been involved throughout the development of this industry-wide response.

SP Energy Networks has also developed its own response to the Secretary of State's call to report, which is contained in this "Climate Change Adaption: Round 4 Update" report.

3. Climate Change Policy & Research

The Intergovernmental Panel on Climate Change (IPCC) who are the United Nations body for assessing the science related to climate change have stated that "*There is a high confidence that global warming is likely to reach 1.5°C between 2030 and 2052 if it continues to increase at the current rate*"[19]. However, the World Meteorological Organization (WMO) have predicted that "*There is an 80 percent likelihood that the annual average global temperature will temporarily exceed 1.5°C*"[20] at some point over the next five years. Although this temporary breech may occur this is not considered a threat to the goals of the Paris Agreement on Climate Change (2016)[21].

Although there are a number of policies from international to local scale outlining targets to limit climate change, the Paris Agreement unites many of the world's nations under a single agreement on tackling climate change. The UK is a signatory and has pledged actions to help mitigate climate change. The Paris Agreement's central aim is to keep a global temperature rise well below 2 degrees Celsius (above pre-industrial levels) and to limit the temperature increase even further to 1.5 degrees Celsius. A range of actions are proposed to support this aim.

Climate Adaptation is also included in the United Nations' Sustainable Development Goals (UN SDGs), and the United Kingdom wishes to demonstrate leadership in the delivery of these goals. As a result, the Greening Government Commitments[22] state that: "Climate resilience planning and mitigation shall be incorporated at all business levels. Strategic climate impact risk mitigation shall be embedded in strategic programmes and plans including estate rationalisation and disposal. Where climate risks are identified, appropriate adaptation actions shall be undertaken".

These statements highlight the importance of not only working towards Net Zero, but also ensuring the network is resilient to these future changes in temperature, and the resulting effect on climate.

[17] ENA's Electricity Networks Climate Change Task Group, 4th Round Climate Change Adaptation Report, December 2024: https://www.energynetworks.org/assets/images/Publications/2024/241218ccar4-report-.pdf?1734688336
[18] ENA's Electricity Networks Climate Change Task Group, 4th Round Climate Change Adaptation Report, December 2024 Annex 2:
https://view.officeapps.live.com/op/view.aspx?src=https%3A%2F%2Fwww.energynetworks.org%2Fassets%2Fimages%2FPublications%2F2024%2F241218adaptation-reporting-power-4-(arp4)-annex-2-risk-assessment.xlsx%3F1734688348&wdOrigin=BROWSELINK
[19] International Panel on Climate Change (IPCC). n.d. Headline Statements [online] [26 March 2021]. Available at: https://www.ipcc.ch/sr15/resources/headline-statements/#:~:text=Sea%20level%20will%20continue%20to,depend%20on%20future%20emission%20pathways.&text=There%20are%20limits%20to%20adaptation,associated%20losses%20(medium%20confidence)
[20] World Metrological Organization (WMO) [online] [03 December 2024]: https://wmo.int/news/media-centre/global-temperature-likely-exceed-15degc-above-pre-industrial-level-temporarily-next-5-years#:~:text=The%20chance%20(80%25)%20of,chance%20between%202023%20and%202027.
[21] United Nations Framework Convention on Climate Change (UNFCC). (2015). The Paris Agreement. Available at: https://unfccc.int/files/essential_background/convention/application/pdf/english_paris_agreement.pdf
[22] UK Gov. (2018). Policy Paper – Greening Government Commitments 2016 – 2020 [online]. [26 March 2021] Available from: https://www.gov.uk/government/publications/greening-government-commitments-2016-to-2020

3.1 Climate Change Research

In considering adaptation to climate change, electricity and gas network companies use the Met Office UK Climate Projection (UKCP18) tool and take into account projections to the end of this century as much of the network infrastructure generally has an operational life expectancy of 30-80 years.

In spring/summer 2020, on behalf of its members, the ENA commissioned the UK Met Office to undertake a review of the UKCP18 data and existing studies in order to understand the changes in potential impact to energy infrastructure assets from climate change. The report from this research has been used to assess the current risks to the energy networks, and to guide future mitigation or management actions. In addition, other tools, for example the Landmark flood mapping tool, have been used by Energy Industry organisations in research and risk assessments independent to the ENA Met Office research.

Because of the diversity of the hazards it was decided to prioritise those which pose the highest risk to energy network assets, and the assessment process was accordingly graded to provide an appropriate focus.

A full climate assessment was produced for the highest priority hazards:

- Prolonged rainfall leading to flooding
- Extreme high temperatures
- Heavy rainfall/drought cycles
- Since there is currently no strong signal within the climate projections for a change to future storm intensity, the risk of strong winds was assessed in the current climate only.

For the remaining lower priority hazards, a qualitative approach was undertaken:

- Sea level rise
- Warm and wetter conditions, followed by heavy rainfall and/or wind
- Storm surge and wave height
- Warmer and wetter conditions – longer growing/nesting seasons
- Snow and ice
- Wildfire
- Lightning
- Solar storm
- Diurnal temperature cycles

3.2 UK Climate Projections

The Met Office UKCP predicts that the UK climate will change significantly between 1990 and 2070[23]. This can be summarised as a greater chance of warmer, wetter winters and hotter, drier summers:

- Winters are between 1 and 4.5°C warmer.
- Winters are up to 30% wetter.
- Summers are between 1 and 6°C warmer.
- Summers are up to 60% drier, depending on the region.
- Hot summer days are between 4 and 7°C warmer.

[23] https://www.metoffice.gov.uk/weather/climate-change/climate-change-in-the-uk

There is also an expectancy by The Climate Change Committee[24] that there will be an increase in frequency and intensity of extremes, though the change can't be quantified due to uncertainty.

3.2.1 Impacts on the Energy Sector

The main impacts on gas and electricity networks from these latest projections remain unchanged from the previous projections:

- Temperature – predicted increase
- Precipitation—predicted increase in winter rainfall and summer droughts.
- Sea level rise—predicted increase.
- Storm surge—predicted increase.
- Increasing wet – dry cycles.
- Increasing windstorm frequency (particularly when following high intensity precipitation).
- Significant cold spells – predicted decrease but more severe.
- Wildfire.

3.3 Met Office Report Outputs

Many of the hazards identified by ENA members are projected to increase due to future climate change: increased frequency of high temperature days, prolonged rainfall events, hourly rainfall extremes, sea-level rise, extreme sea level events, increased risk of wildfire and increased extreme diurnal cycle events are all expected over the 21st century. On the other hand, the frequency of snow and ice days are expected to decrease. Hazards for which there is not currently strong evidence for a change in frequency include strong wind events, high wave heights, wetter conditions coincident with warmer temperatures and/or strong winds, lightning and to some extent, diurnal temperature cycles. Solar storms are not affected by increased greenhouse gases, so a study of historic occurrence of this hazard was presented.

The societal response to climate change has also been considered in the context of hazards to the energy network. Impacts of the weather hazards on the energy network are likely to come in the form of an altered dependency between weather and both supply and demand. Increases to the prevalence of electrified heating and electric vehicles in turn increases the reliance on the electricity network by our consumers. This increases the impact of hazards on our electricity network.

Interconnections between different industry sectors is a major source of risk for the energy network, with failures from one sector frequently causing impacts. Telecommunications and road transport are thought to be the most important sources of risk. Telecommunications are already important for automated and remotely controlled equipment, and for communication with personnel in the field. Risk from telecommunications failure has the potential to increase in the future with greater reliance on smart systems (dependent on telecommunications). Road transport is often essential for restoration of supply and access to assets for routine maintenance and emergency restoration. Societal responses to climate change may also increase the risk on the road network from the electricity network, as electric vehicles become more commonplace.

[24] https://www.theccc.org.uk/wp-content/uploads/2021/07/Independent-Assessment-of-UK-Climate-Risk-Advice-to-Govt-for-CCRA3-CCC.pdf

4. Summary of Climate Change Projections

This section looks at the most likely and worst-case possibilities for what the future climate may be. UKCP18 data has been used to gather climate change projections for the UK. This data is based on the 2020 review that was undertaken by the Met Office UK which was commissioned by the ENA on behalf of its members. The Met office looked at the UKCP18 data to provide an RCP 8.5 worst case scenario in order to understand the changes in potential impact to energy infrastructure assets from climate change.

This work includes the analysis of projections for weather extremes and prolonged periods of adverse weather, forming the basis for the climate risk assessment. As per the adaptation reporting guidance, issued by DEFRA, no new climate data projections have been included within our ARP4 risk assessment, rather we have built on our ARP3 risk assessment template to better understand our climate risk. However, this section does include the most up to date climate projections from the UK Met Office UKCP data.

In our ARP3 submission we included climate scenarios for the following time periods: 2030s, 2050s and 2100s. For each time-period, two scenarios, based on two Representative Concentration Pathways (RCP), RCP6.0 and RCP8.5, were used to provide projections of how the climate may change in the future. The best estimate of global average temperature rise by 2100 for RCP8.5 is 4.3°C (3.2-5.4°C). However, this report only focuses on the higher risk scenario, RCP8.5. The RCP8.5 scenario is suggested will occur by close of the current century if global emissions continue unabated at their current rate.

This change is justified by the fact that this is the worst-case scenario, and the industry as a whole is moving collectively to adopt this worst-case scenario, as such the 4°C scenario will encompass 2°C scenarios by default, as referenced by the Climate Change Committee[25].This baseline climate projection has been used to determine the impact climate risks currently have on SP Energy Networks, and how the climate change projections present the likelihood of climate risks in the future.

Climate variables have been extracted for the whole of the UK, in alignment with our 2015 Risk Assessment (with the exception of sea level data which were selected from specific tide gauges close to SP Energy Networks regions). The temperature and precipitation variables are taken from the UKCP18 25km land probabilistic projections, whilst the wind speed projections are taken from global 60km-resolution models. In this report, the baseline period of 1981 – 2010 is used for assessing the projected future climate change anomalies. However, due to data availability, it should be noted that the sea level rise projections used in this analysis are relative to a 1981 – 2000 baseline. This section gives consideration to observed climate change, observed extreme weather events and the current situation with respect to drought, severe weather and flooding and management of vegetation growth.

4.1 Observed Climate Change

According to the latest State of the UK climate report (2023),[26] the UK has experienced headline changes presented below. It is assumed that these changes will continue in a similar trajectory into the future:

- The UK mean temperature (T_{mean}) for 2023 increased by 0.83°C above the 1991–2020 long-term average up to 9.97°C, Figure 2;
- The most recent decade (2014–2023) the UK seasonal mean temperature for summer was 1.2°C warmer than the 1961 – 1990 average and 0.4°C warmer than the 1991 – 2020 average;
- The most recent decade (2014–2023) has had the six of the warmest years within the top ten warmest in the series;

[25] Committee on Climate Change (2023) Progress in adapting to climate change – 2023 Progress Report to Parliament. [Viewed 03.12.2024].: https://www.theccc.org.uk/wp-content/uploads/2023/03/WEB-Progress-in-adapting-to-climate-change-2023-Report-to-Parliament.pdf

[26] *Met Office, 2023, State of the UK climate [online]. Met Office. [viewed 01 December 2024]. Available from: https://www.metoffice.gov.uk/research/climate/maps-and-data/about/state-of-climate*

- Observations show that extremes of temperature in the UK have been affected much more than average temperature. The number of 'hot' days (28°C) has more than doubled and 'very hot' days (30°C) more than trebled for the most recent decade (2014-2023) compared to 1961-1990;
- 2023 was the seventh wettest year on record for the UK in the series from 1836, with 113% of the 1991-2020 average. March, July, October and December 2023 were all top-ten wettest months;
- Five of the ten wettest years for the UK in the series from 1836 have occurred in the 21st Century;
- The most recent decade (2014–2023) has been on average 2% wetter than 1991–2020 and 10% wetter than 1961–1990 for the UK overall (values provided in Table 1).
- Mean sea-level around the UK has risen by approximately 1.5 mm/year from the start of the 20th century, and 2.4mm since 1960;

Table 1: Average annual rainfall values (mm) across the UK and England, Scotland, and Wales.

Area	1961 – 1990	1991 – 2020	2014 – 2023	2023
UK	1084	1163	1191	1319
England	820	870	898	1066
Wales	1380	1465	1513	1716
Scotland	1444	1573	1592	1622

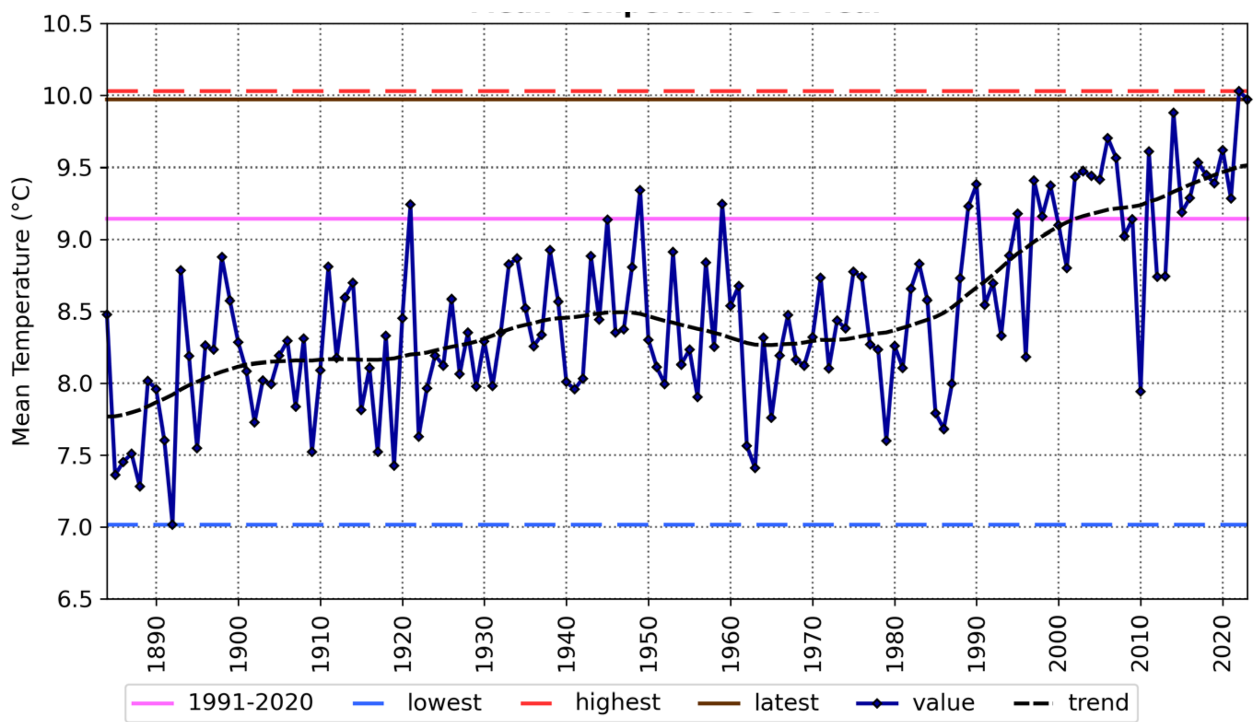

Figure 2: Mean Annual UK Temperature T_{mean} (°C) (1884-2023).

4.1.1 Observed Weather Events

As with national trends, areas to which we operate have been experiencing changes to annual temperatures and precipitation since the 1980s, as well as severe extreme weather events that has resulted in disruptions to water supply, energy supply, travel delays and human health impacts.

Understanding how we have been impacted in the past by climate risks forms the impact rating given to climate hazards in the climate change risk assessment.

Table 2: Previous severe weather events which have caused impacts to SP Energy Networks[27]

Type	Date	Description	Impacts
Storms (N.B. Only recent notable events are listed)	7 - 8 Dec 2024	Storm Darragh Wind Speeds: 96mph	Statistics and impact assessment is currently ongoing.
	18-19 Feb 2022	Storm Eunice Wind Speeds: 84mph	15,000 customers impacted in SPM with 87% restored within 6 hours, 98% restored within 12 hours and 100% restored within 24 hours.
	7-8 Dec 2021	Storm Barra Wind Speeds: 86mph	19,283 customers impacted with their power restored in under 12 hours.
	26-27 Nov 2021	Storm Arwen Wind Speeds: 98 mph	190,000 customers impacted in SPD & SPM with 88% restored within 24 hours and 96% within 48 hours. Final customers reconnected within 6 days.
	19-22 Jan 2021	Storm Christoph Flooding in North Wales, impacting and inundating substations.	13,045 customers impacted in SPM with 99% restored within 12 hours and 100% restored within 24 hours.
Drought	2010 - 2012	Much of central, eastern, and southern England and Wales experienced a prolonged period of below average rainfall from 2010 to early 2012	Low reservoir levels: hosepipe bans across north-west England affecting six million consumers; widespread agricultural and environmental issues
Heatwave	July 2006	Sustained warmth and prolonged sunshine resulted in the month of July 2006 being the warmest single month on record over much of the UK[28]. For example, in the first four days of the month maximum temperatures exceeded 28 °C widely across England and Wales, weather that was to recur on many days later in the month.	Disruptions to water and energy supply; Travel delays and disruptions (for example, heat damage to tarmac road surfaces and speed restrictions on railways due to the risk of buckling); Health impacts from heat stress; Strain on health and fire services; Numerous grass/heath/forest fires; Increased tourism
	August 2003	A 10-day UK-wide heatwave, with a record maximum of 38°C.	Health impacts and fatalities from heat; Low river flows and lake levels; High incidence of forest fires; Reduced water supplies; Fatality of livestock and crop failure; Travel delays and disruptions
Flooding	February 2020	UK-wide flooding brought about by intense rainfall of up to 180mm in a single 18-hour period from Storm Ciara and Storm Dennis, alongside 85mph winds.	Travel delays and disruption Flooding of properties and agricultural land Over the 69-hour duration of the storm, 19,688 customers were affected (92% restored within 3 hours, 100% within 25 hours) across North Wales.

[27] SP Energy Networks. (2021). Exceptional Events Register

[28] Met Office. (2012). Record breaking heat and sunshine - July 2006. [viewed 12th April 2021]. Available from: https://www.metoffice.gov.uk/binaries/content/assets/metofficegovuk/pdf/weather/learn-about/uk-past-events/interesting/2006/record-breaking-heat-and-sunshine---july-2006---met-office.pdf

Storm Arwen, which occurred 26 – 27 November 2021, caused widespread electricity disruption to almost 1 million customers across the whole of the UK. The Rt Hon Charles Hendry CBE said "*The scale of the damage caused by Storm Arwen is some of the worst the UK's power networks have experienced in over 25 years.*" While 83% of disrupted customers had their power restored within 24 hours, a small but significant proportion experienced a disruption of up to 11 days[29]. As a result, Ofgem and DESNZ (at the time BEIS) launched independent reviews into the impact of Storm Arwen[30]. The impact of Storm Arwen was a watershed moment in the energy sector and as a result of both industry and company reviews, this led to a change which now puts climate network resilience at the forefront of planning and investment.

4.2 Climate Projections

This section summarises the projected climate changes for temperature, precipitation, sea level rise and wind using UKCP18 data for four time periods up until the end of the century. Between ARP3 & ARP4 the data provided by the Met Office has changed from a 30-year to 20-year time slice periods as such the data presented in the tables show four time periods instead of three. The data also shows an upwards trend for both temperature and precipitation.

4.2.1 Temperature

Human activities are estimated to have caused approximately 1.3°C[31] of global warming above pre-industrial levels, with a likely range of 1.1°C to 1.6°C. There is a high confidence that global warming is likely to reach 1.5°C between 2030 and 2052 if it continues to increase at the current rate.

Headline trends

- There is an expected increase of temperature across all seasons with disproportionate increases in extreme high summer temperatures, leading to increased cooling demand and higher likelihood of SP Energy Networks' assets overheating.

Projected climatic parameters for UK temperature change are presented in Table 3 based on RCP8.5 over 20-year averages. Towards the end of this century, for the RCP8.5 scenario, 50% of climate model results showed warming of up to 4.95°C to the mean summer air temperature, 3.38°C to the mean winter temperature, 5.38°C to the maximum summer temperature and 3.55°C to the minimum winter temperature.

UKCP18 data showed that the UK will experience warmer wetter winters and hotter drier summers on average[32]. Colder than average winters and summers will still occur but will become less likely the further we go into the 21st century. Additionally, the Intergovernmental Panel on Climate Change (IPCC) noted that cold episodes were projected to decrease significantly in a future warmer climate. However, it has also been suggested that the decrease in sea ice caused by the mean warming could induce, although not systematically, more frequent cold winter extremes over northern continents. Therefore, it is important to still be prepared for extreme cold temperatures and snow in the future as they are likely to occur, even if less frequently.[33]

[29] **N.B.** Although some GB customers were affected for up to 11 days, this did not include any SPEN customers.
[30] https://www.gov.uk/government/publications/storm-arwen-electricity-distribution-disruption-review
[31] https://climateanalytics.org/publications/global-warming-reaches-1c-above-preindustrial-warmest-in-more-than-11000-years#:~:text=Given%20the%20lack%20of%20action,1.5%C2%B0C%20by%202100.
[32] Met Office, UK extreme events – Cold [viewed 01 Dec 2024]. Available from: https://www.metoffice.gov.uk/research/climate/understanding-climate/uk-extreme-events_cold
[33] *IPCC (2012) Changes in Climate Extremes and their Impacts on the Natural Physical Environment. Available from: https://www.ipcc.ch/site/assets/uploads/2018/03/SREX-Chap3_FINAL-1.pdf*

Table 3: Projected UK temperature change under RCP8.5, relative to a 1981 – 2000 baseline (10-90% range of models shown in parentheses).

Temperature variable	Climate Hazard	2020 - 2039	2040 - 2059	2060 - 2079	2080 - 2099
Change in mean annual air temperature anomaly at 1.5m (°C)	Temperature Increase	+0.92 (0.36 to 1.51)	+1.63 (0.77 to 2.49)	+2.58 (1.29 to 3.87)	+3.86 (2.18 to 5.59)
Change in mean summer air temperature anomaly at 1.5m (°C)	Heat waves Wildfires	+1.20 (0.38 to 2.02)	+2.15 (0.94 to 3.36)	+3.25 (1.46 to 5.06)	+4.95 (2.59 to 7.41)
Change in mean winter air temperature anomaly at 1.5m (°C)	Ice and snow	+0.90 (0.13 to 1.73)	+1.54 (0.44 to 2.71)	+2.34 (0.81 to 4.04)	+3.38 (1.40 to 5.53)
Change in maximum summer air temperature anomaly at 1.5m (°C)	Heat waves Wildfires	+1.29 (0.18 to 2.36)	+2.32 (0.76 to 3.91)	+3.50 (1.26 to 5.78)	+5.38 (2.43 to 8.48)
Change in minimum winter air temperature anomaly at 1.5m (°C)	Ice and snow	+0.91 (0.06 to 1.86)	+1.62 (0.38 to 3.02)	+2.48 (0.66 to 4.53)	+3.55 (1.24 to 6.22)

4.2.2 Precipitation

Projected climatic parameters for UK precipitation change are presented in Table 4 based on RCP8.5.

Headline trends

- Winter precipitation projected to increase, increasing the risk of flooding at substations.
- Extreme hourly rainfall projected to increase in winter.
- Decrease in summer precipitation increasing the likelihood of drought, increasing risks of earth and ground movement on SP Energy Networks' assets.

As we approach the end of the current century, for the RCP8.5 scenario, 50% of climate model results showed an annual increase of 3.03% in rainfall, a 17.29% increase in winter rainfall and a 27.53% decrease in summer rainfall.

Table 4: Projected UK precipitation change under RCP8.5, relative to a 1981 – 2010 baseline (10-90% range of models shown in parentheses).

Precipitation variable	Climate Hazard	2020 - 2039	2040 - 2059	2060 - 2079	2080 - 2099
Change in mean annual precipitation rate anomaly (%)	Flooding	+2.35 (-1.90 to 6.75)	+1.21 (-3.83 to +6.12)	+2.58 (-3.71 to +8.94)	+3.03 (-4.90 to +11.04)
Change in mean winter precipitation rate anomaly (%)	Flooding	+5.25 (-2.63 to +13.88)	+6.65 (-3.76 to +19.07)	+13.50 (-1.25 to +31.09)	+17.29 (-0.76 to +39.26)
Change in mean summer precipitation rate anomaly (%)	Drought	-2.83 (-16.61 to +10.90)	- 11.79 (-27.79 to +4.00)	-18.11 (-37.39 to +0.77)	-27.53 (-48.48 to -+4.48)

4.2.3 Sea Level Rise

The projected increases in mean sea level anomaly by 2100 relative to 1981 – 2000 are shown in Table 5 and Figure 4. Under RCP8.5 in Figure 4, sea level rise projections from UKCP18 models by the end of the century range from 0.3-0.91m in the west and east coasts of Scotland and 0.44-1.05m in North Wales and Merseyside.

Headline trends

- Sea level will continue to rise up-to and beyond the end of the 21st century, with projections up to 1 m by 2100 under a high emission scenario.
- Extreme sea levels will increase due to the rise in mean sea level, increasing the risk of coastal flooding and erosion to our coastal assets.

Extreme sea levels will increase due to the rise in mean sea level, affecting the likelihood of coastal flooding and coastal erosion. There is potential for changes in the severity of future storm surge events, but it is unknown from the model results whether the frequency and severity of storm surge events will increase.[34]

Table 5: Time-mean sea level anomaly (m) with 5-95% range of models shown in parentheses.

Region	2030	2050	2100
SPD			
West Scotland	0.09 (0.05 - 0.14)	0.19 (0.10 - 0.29)	0.55 (0.30 - 0.91)
East Scotland	0.09 (0.05 - 0.14)	0.19 (0.10 - 0.29)	0.55 (0.30 - 0.91)
SPM			
North Wales & Merseyside[35]	0.13 (0.09 - 0.18)	0.26 (0.17 - 0.37)	0.69 (0.44 - 1.05)

[34] *Met Office, 2023. UKCP18 Factsheet: Sea level rise and storm surge [online]. Met Office. [viewed 02 Dec 2024]. Available from: https://www.metoffice.gov.uk/binaries/content/assets/metofficegovuk/pdf/research/ukcp/ukcp18_factsheet_sea_level_rise_storm_surge_supp_data_mar23.pdf*

[35] Due to very similar levels at North Wales and Merseyside gauges, one location has been used to represent the North Wales & Merseyside area.

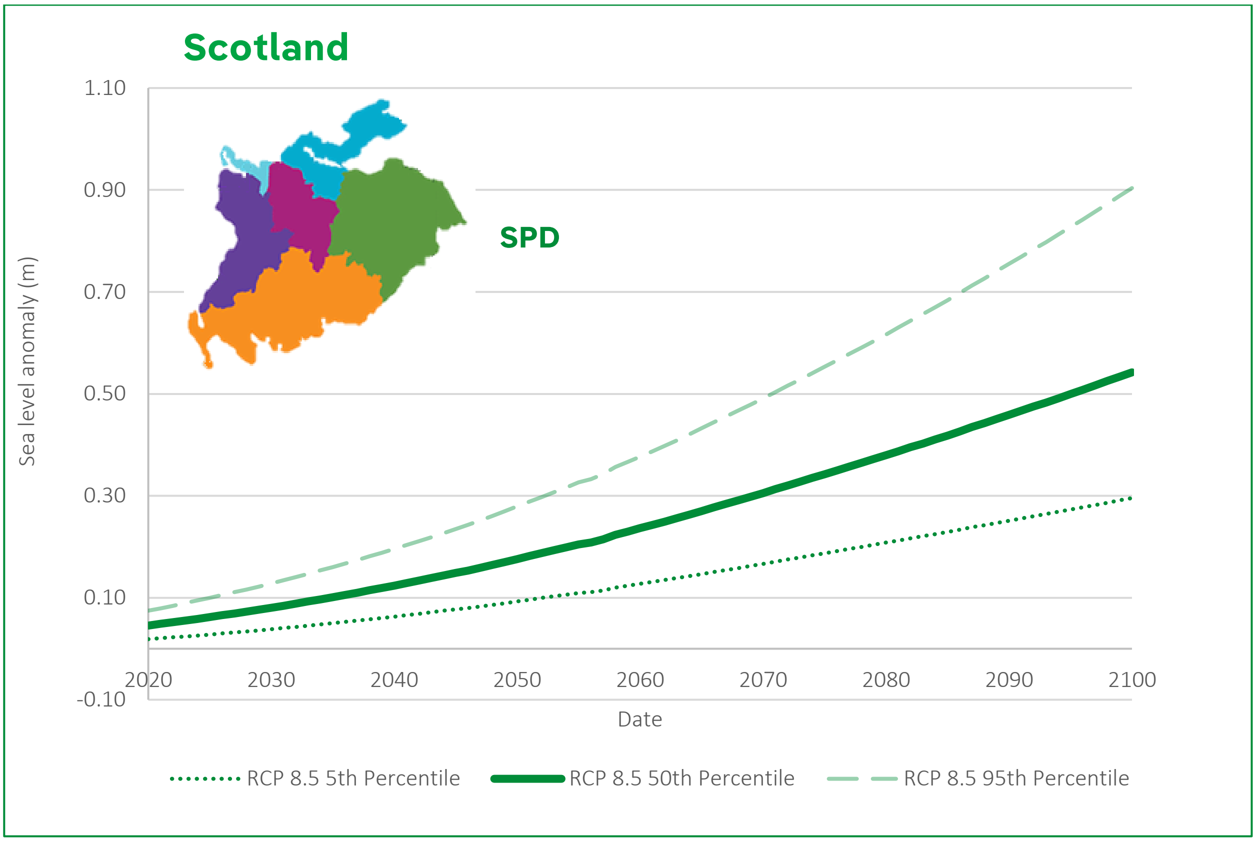

Figure 3: 21st century mean sea level rise anomaly (m) for SPD within SP Energy Networks under RCP8.5 relative to 1981-2000.

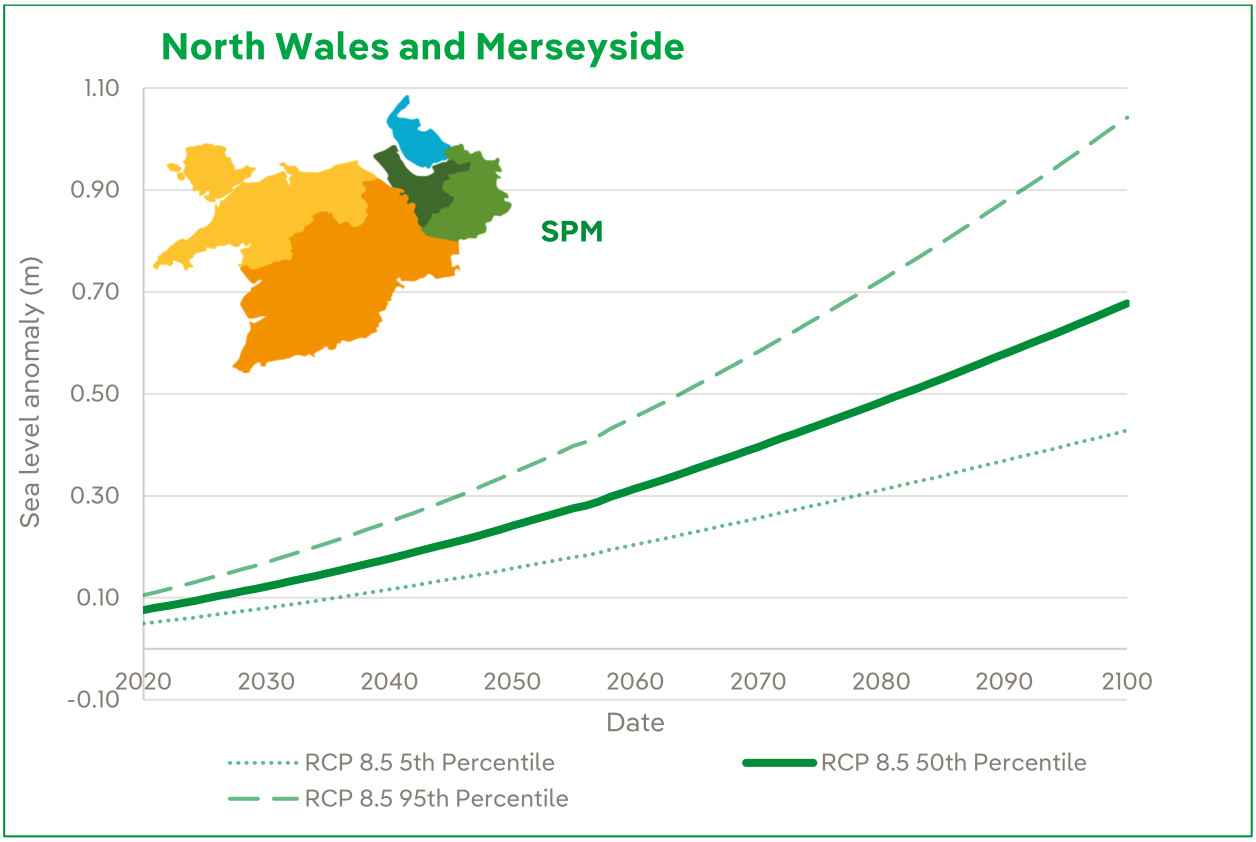

Figure 4: 21st century mean sea level rise anomaly (m) for SPM within SP Energy Networks under RCP8.5 relative to 1981-2000.

4.2.4 Wind / Storminess

UKCP18 projections show an increase in near surface wind speeds over the UK for the second half of the 21st century for the winter season, with some climate models in the Met Office PPE-15 (Figure 5) ensemble displaying large peaks in some years. However, the increase in wind speeds is modest compared to interannual variability.

Headline trends

- Interannual and decadal variability of windstorms.
- An increase in near surface wind speeds over the UK for the second half of the 21st century for the winter months, increasing the risk of damage to SP Energy Networks' overhead lines.
- There is currently no strong signal within the climate projections for a change to future storm intensity.
- Poleward shift of storm tracks, increasing storm activity in higher latitudes (GB), could lead to more frequent storms – of uncertain intensity compared to historical

In terms of storminess and lightning, there is currently limited data about the response of these hazards to climate change, so it is not possible to provide projections of change in frequency and severity. Since there is currently no strong signal within the climate projections for a change to future storm intensity, these risks have been assessed as per the current climate, for example the out-of-season storm that impacted the SP Energy Networks in August 2024 (Storm Lillian). It is recognised that prevailing wind direction is a potential hazard for SP Energy Networks, but, like storminess, there is a lack of climate model trends for this variable. However, on a global scale, the IPCC suggests that in a warmer climate there could be a poleward shift of storm tracks, increasing storm activity in higher latitudes, typically associated with increased ocean temperatures[36].

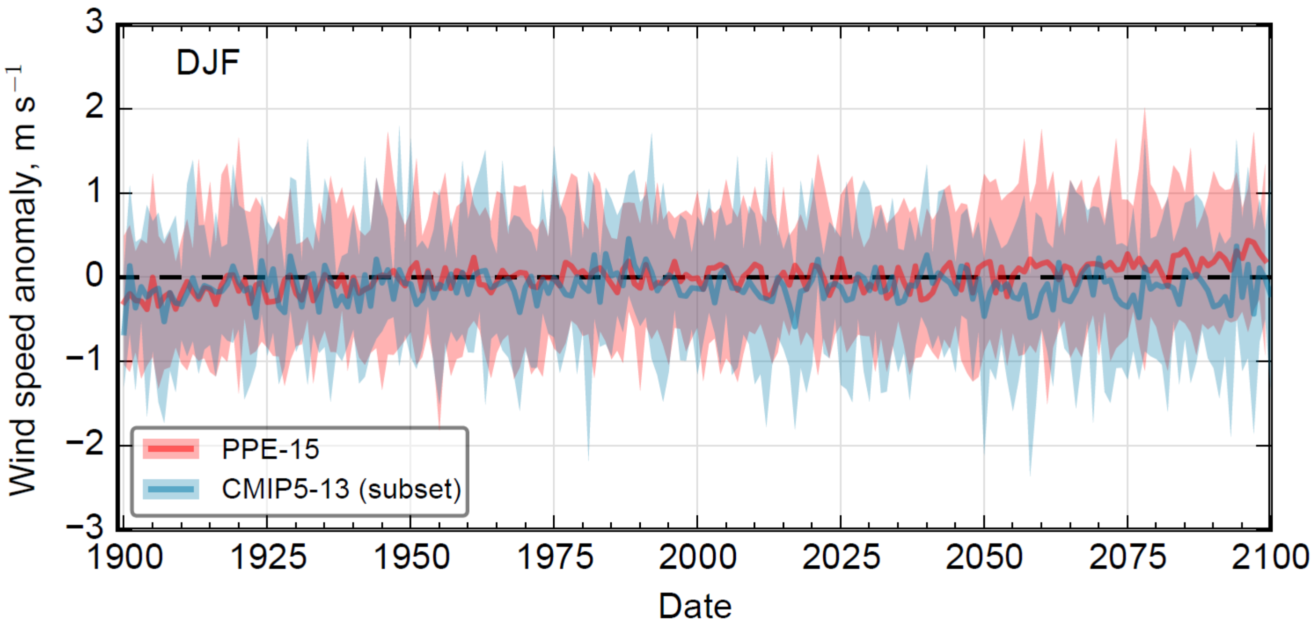

Figure 5: Winter wind speed anomaly at 10m (m s-1) for the UK under RCP8.5 in comparison to the 1981-2010 baseline, from 15 simulations of the Met Office Hadley Centre model (PPE-15).[37]

[36] *IPCC. (2018). Global Climate Projections, Chapter 10. [Online]. [Viewed 31/03/2021]* *https://www.ipcc.ch/site/assets/uploads/2018/02/ar4-wg1-chapter10-1.pdf*

[37] https://www.metoffice.gov.uk/binaries/content/assets/metofficegovuk/pdf/research/ukcp/ukcp18-fact-sheet-wind_march21.pdf

PPE-15 refers to a set of climate model projections used in the UK Climate Projections 2018 (UKCP18) framework. Specifically, it stands for "Perturbed Parameter Ensemble" and includes 15 different versions of the Met Office Hadley Centre model. These models incorporate variations in key parameters to account for uncertainties in climate projections.

CMIP5-13 refers to a subset of climate models from the Coupled Model Intercomparison Project Phase 5 (CMIP5). Specifically, it includes 13 different global climate models used to simulate past, present, and future climate conditions. These models are part of a larger effort to improve our understanding of climate change by comparing the outputs of various climate models under standardized scenarios.

The CMIP5 models are widely used in climate research and have contributed significantly to reports by the Intergovernmental Panel on Climate Change (IPCC). They help scientists assess the range of possible future climate changes and understand the mechanisms driving these changes.

5. Progress Since 3rd Round Reporting

As a business, we have been focusing on managing key climate risks since the publication of our Adaptation Reports in 2011, 2015 and 2021 respectively. As a result, we have carried out several adaptive actions across key function areas across the network.

We have recently submitted our draft RIIO-T3 business plan[38] to Ofgem. As part of this Business Plan, we have included an Annex that contains our Climate Resilience Strategy. This strategy highlights the key risks to our Transmission Network such as flooding, landslides, temperature etc. We are planning to undertake interventions at several of our transmission asset locations to mitigate against the highest risks identified in the strategy. This follows on from our commitment during our RIIO-ED2 business plan submission in December 2021 to carry out flood mitigation works across both SPM & SPD. The ED2 programme is currently ongoing with a number of sites already being made flood resilient as per the requirements of our flood policy, SUB-01-018. As part of our business plan submissions we produced Engineering Justification Papers (EJPs) for Flood Resilience. These EJPs detail our proposed programmes of flood mitigation works across the three licence areas of SP Energy Networks, aiming to ensure compliance with ETR 138[39].

The papers outline the strategy for flood mitigation within the RIIO-T3 & RIIO-ED2 periods that SPEN will undertake to reduce the risk of the network from coastal, fluvial, and pluvial flooding, in response to following key risks identified:

AR10 – Substations affected by fluvial (river) flooding due to increased winter rainfall, with loss of ability to function leading to reduced security of supply.

AR11 – Substations affected by pluvial (surface water) flooding due to severe rainfall, with loss of ability to function leading to reduced security of supply.

AR12 – There is a risk that due to extreme sea flooding a substation may be lost or unable to function leading to reduced system security of supply. A number of sites may be at risk from sea level rise/coastal erosion.

Impact of flooding on our ground located assets can have significant impact on our networks leading to loss of supply no matter the source of flooding. The necessary repair or replacement of flood damaged assets is costly and time consuming, potentially extending periods of loss of supply beyond the initial flood event.

This strategy will ensure compliance with the requirement within ETR 138 "Resilience to Flooding of Grid and Primary Substations" to protect substations against a 0.1% (1 in 1000 year) & 1% (1 in 100 year) Annual Exceedance Probability' (AEP) flood events (refer to Table 6), based on voltage and customer numbers, and provide network security from the effects of flooding, with investment being taken between 2021-2031.

5.1 ETR 138 – Resilience to Flooding of Grid and Primary Substations

ETR 138 was first issued in October 2009 in response to widescale flood events in 2007 which inundated a number of substations across the UK, leading to a large number of homes to stay off supply for several weeks. It has served as the industry standard for protecting substations from flooding since. The minimum resilience levels as specified by ETR138 can be found in Table 6 below.

Following flooding events in 2015 which resulted in some large substations being affected within the UK, the government undertook a review for flood resilience of critical infrastructure. The review recommendations called for the development for longer term plans for permanently improving the resilience of service provision to sites supplying significant local communities. This recommendation was the driver for Issue 3 (2018) of ETR 138 to include increased resilience for sites with greater than 10,000 unrecoverable customers/connections.

Within SP Energy Networks we have incorporated the ETR 138 recommendations into our 'Substation Flood Resilience Policy' SUB-01-018. This policy document applies to substations at all voltages within SP Energy

[38] https://www.spenergynetworks.co.uk/userfiles/file/RIIO-T3%20Business%20Plan%20-%20SP%20Energy%20Networks%20-%20Website%20-%20December%202024.pdf
[39] ENA Engineering Technical Report (ETR) 138 "Resilience to Flooding of Grid and Primary Substations"

Networks and sets out the standards for flood resilience work at existing substations on the network, as well as defining resilience levels to be incorporated into new substations.

Substation Type	Flood Resilience Level
Grid Substations	Protection against the level of flooding that may occur within a 0.1% AEP event (1:1,000-year flood) for fluvial, pluvial and coastal flooding.
Primary Substations (33kV) (>10,000 unrecoverable connections)	Protection against the level of flooding that may occur within a 0.1% AEP event (1:1,000-year flood) for fluvial, pluvial and coastal flooding.
Primary Substations (33kV) (<10,000 unrecoverable connections)	Protection against the level of flooding that may occur within a 1% AEP event (1:100 year) fluvial and pluvial flood (0.5% AEP (1 in 200 year) in Scotland) and within the 0.5% AEP event (1:200 year) for coastal flooding throughout GB .
Secondary Substations	Not normally protected but may require protection in certain circumstances.

Table 6: ETR 138 Flood Resilience Levels

Although ETR 138 sets the 'minimum' standard for protection of substation assets and forms the basis for SUB-01-018 we have taken the decision to increase the level of freeboard at substations at risk of flooding, this will increase resilience at substations at risk of flooding which will in turn improve resilience for the network.

Although secondary substations do not have a defined requirement to be protected against a specific flood return level, in instances where flooding is resulting in repeat loss of supply, action shall be taken to protect or move the asset. In accordance with SUB-01-018, new secondary substation installations shall be checked against the 0.5% AEP (1 in 200 year) (SPD) and 1%/0.5% AEP (1 in 100/200 year) (SPM) flood maps and the plinth constructed above the flood level where reasonably practicable to do so. (This approach has been endorsed by our recent stakeholder engagement on which activity is prioritised).

5.2 Updated risk assessments

The ENA 4th Round Climate Change Adaption Report, December 2024[40], has provided a collaborative update on existing risks, mitigation measures and programmes to provide an overall view of the potential for climate change impacts to affect energy networks. As previously mentioned, the report was prepared by a task group of gas and electricity distribution and transmission network operator members of the ENA and is intended to provide a response to climate change adaption on behalf of the Energy Industry. Whilst the ENA report provides an industry wide view each TNO/DNO is required to provide an update to each company risk level. Because of this our risk level is shown to be higher than that reported by the wider industry report. The ENA report has been used as the foundation for the work presented within this report.

Following the updates to ETR 138, climate change allowances and flood modelling, SP Energy Networks consider risk of flooding as the highest risk climate change variable affecting our network in the short term, as we have ground-based assets that currently do not have the required flood mitigation in place to meet the requirements detailed in Table 6. Recognising the importance of implementing a more detailed strategy to mitigate the wider impacts of climate change in addition to flooding, SP Energy Networks has produced our own risk assessment and mitigation strategy, and this is presented within the following sections.

The adaptation risks that were used in the 3rd round have been retained and reviewed and evaluated as part of the ARP4 process. The three highest rated risks identified in our 3rd round report: AR10, AR11 and AR12, were all rated as "Very High".

[40] ENA's Electricity Networks Climate Change Task Group, 4th Round Climate Change Adaptation Report, December 2024: https://www.energynetworks.org/assets/images/Publications/2024/241218ccar4-report-.pdf?1734688336

6. Risk Assessment Summary

This section identifies the key climate risks and determines the adaptation tipping points of our network and business functions. The risk matrix shown below developed in line with the Energy Network Association (ENA) 4th Round Climate Change Adaptation report[41] identifies accepted risk levels, asset and function performance threshold levels, and minimum performance requirements.

Table 7: Scoring matrix used to determine the significance of risks for SP Energy Networks

Relative Impact						
	Extreme	5	10	15	20	25
	Significant	4	8	12	16	20
	Moderate	3	6	9	12	15
	Minor	2	4	6	8	10
	Limited	1	2	3	4	5
		Very Unlikely	Unlikely	Possible	Expected	Almost Certain
		Relative Likelihood				

The below tables (Table 8 & Table 9) outlines the definitions associated with the relative impact and likelihood classifications of risks. The impact relates to the scale of the area affected by the hazard and the likelihood is based on how frequent the event causing the risk occurs and is likely to occur in the future based on climate projections.

The risk assessment is built on the understanding and identification of the tipping point of functions in the power system. This is the point when the function of different parts of the power system is no longer viable in relation to the projected climate parameters, such as temperature thresholds and flood capacity, and so adaptation actions are therefore required.

Table 8: Impact classification definitions

Relative Impact	
Extreme	Regional area affected with people off supply for a month or more/OR asset de-rating exceeds ability to reinforce network leading to rota disconnections on peak demand.
Significant	County or city area affected with people off supply for a week or more OR asset de-rating requires a significant re-prioritisation of network reinforcement and deferment of new connection activities
Moderate	Large town or conurbation off supply for up to a week OR significant increase in cost of network strengthening.
Minor	Small town off supply for a 24-hour period OR significant increase in cost of network maintenance requirements.
Limited	Limited impact - can be managed within "business as usual" processes

[41] ENA's Electricity Networks Climate Change Task Group, 4th Round Climate Change Adaptation Report, December 2024 – https://www.energynetworks.org/assets/images/Publications/2024/241218ccar4-report-.pdf?1734688336

Table 9: Likelihood classification definitions

Relative Likelihood	
Very Unlikely	No known event or if known extremely rare, extreme industry-wide scenarios
Unlikely	Events are rare, required mitigations in place, controls are effective
Possible	Past events satisfactorily resolved, mitigations are in place or are on track to be in place, control improvements are under active management
Expected	Past events have not been fully resolved, effective mitigations not yet identified, control weakness are known and are being managed.
Almost Certain	The risk in the process of materialising and may already be under active management as an event

The impact score has been highlighted in each risk table as it is assumed that the impact would remain constant while the likelihood changes in relation to climate projections. Climate hazards associated with each risk are also included in the table and relate to at least one of the climate variables presented in Section 4: temperature; precipitation; sea level rise; and wind/storminess. The risks have been separated into function categories as follows:

Network Risks

- Overhead lines, poles & towers
- Underground cables
- Transformers
- Substation Sites
- Vegetation management
- Network Loading

Business Risks

- Emergency Response and planning
- Routine business and maintenance
- Customer Service

Table 10 presents the meaning behind the risk ID given to all the risks identified, some of the IDs are legacy ones given in the SP Energy Networks 2015 CCRA[42], the rest were created in our third round ARP[43].

Table 10: Key for risk ID and source of ID

ID	Name, Source	ID	Name, Source
AR	Risk originally identified by the ENA first report, SP Energy Networks CCRA 2015	GN	Generation/Network Loading, RIIO-ED2 Climate Resilience Working Group 2021
NG	Risk originally identified by National Grid Electricity Transmission plc report, SP Energy Networks CCRA 2015	ER	Emergency Response, RIIO-ED2 Climate Resilience Working Group 2021
SP	Risks specific to SP Energy Networks identified, SP Energy Networks CCRA 2015	RB	Routine Business, RIIO-ED2 Climate Resilience Working Group 2021
VM	Vegetation Management, AECOM 2021	CS	Customer Service, RIIO-ED2 Climate Resilience Working Group 2021

[42] SP Energy Networks. (2015). Climate Change Adaptation Report, Round 2 Update: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/479266/clim-adrep-sp-energy-networks-2015.pdf
[43] SP Energy Networks. (2021). Climate Change Adaptation Report, Round 3 Update: https://www.spenergynetworks.co.uk/userfiles/file/ClimateChangeAdaptationReport_3rdRoundUpdate_FinalIssue.pdf

The remainder of this section is presented in two parts:

- Section 6.2 – Key Network Risks relating to assets and infrastructure, as set out above.
- Section 6.3 – Key Business Risks relating to people, processes and systems required to operate effectively and safely, and meeting our customers' expectations, as set out above.

The ARP3 and ARP4 risk scores sees little variation, if any, due to the time period between rounds three and four only being 3 years. The Key Network Risk scores largely stay the same with some minor variations whilst our Emergency Response, Routine Business and Customer service score have not changed.

6.1 Confidence Ratings

To calculate the risk scores for 2050 and 2100 we have had to rely on the assumptions of future climate projections. These assumptions would increase uncertainty further into the future that the prediction is made. The scoring for all scenarios (2050 & 2100) are subject to unforeseen variables. As such there is a degree of confidence that needs to be applied to each risk score. 2050-70 projections in current climate data have reasonable confidence, however beyond 2070, confidence decreases significantly as a result of a lack of definitive projections and uncertainty.

6.2 Key Network Risks

The following outlines the key network risks specifically posed to SP Energy Networks and the change in risk scores between ARP3 & ARP4.

6.2.1 Overhead Lines, Poles and Towers

Overhead lines (OHL), poles and towers are a key element of our infrastructure, consisting of 606,600 poles and towers and 40,000 km of OHL. Risks associated include the direct risk temperature poses to the capability of the asset to operate, and the risk posed by many climate variables on the structural integrity of the asset, in some cases increasing the deterioration.

Table 11: Climate risks posed to overhead lines, cable bridges & towers

Risk ID	Climate Hazard: Risk	ARP3 Impact Score	ARP3 Risk Score			ARP4 Impact Score	ARP4 Risk Score		
			2030	2050	2100		2030	2050	2100
AR1	Increased Temperature: Overhead line conductors affected by temperature rise and increased cooling demand, reducing rating and ground clearance.	3	High 9	High 12	High 15	3	High 9	High 12	High 15
AR2	Summer Drought: Overhead line structures affected by summer drought and consequent ground movement.	2	Med 4	Med 6	Med 8	2	Med 6	Med 9	Med 8
AR3	Prolonged growing season: Overhead lines affected by interference from vegetation	3	High 15	High 15	High 15	3	High 15	High 15	High 15
AR14	Increased Lightning activity: Overhead lines affected by increased lightning activity.	2	Med 6	Med 8	Med 10	2	Med 6	Med 8	Med 10
AR15	Hurricanes & High Winds: Overhead line structures affected by wind speeds not accommodated for in design.	3	High 9	High 12	High 15	3	High 9	High 12	High 15
NG1	Sea Level Rise: A number of sites may be at risk from sea level rise. Sites may become non-operational due to sea inundation potentially leading to a loss of system resilience or a loss of supply.	3	Med 3	High 6	High 9	3	Med 3	High 6	High 9

NG3	Increased River Erosion from Increased Precipitation: If foundations are exposed, weakened or soil stability is reduced lines may fail.	3	High 9	High 12	High 15	3	High 9	High 12	High 15

6.2.2 Underground Cables

The risks posed to underground assets can cause moderate to extreme impacts due to the size of the network affected, and access issues related to resolving underground faults. We have around 65,000 km of underground cable assets. Although temperature change experienced underground is not as extreme as the ambient air temperature changes, fluctuations in temperature can cause significant impacts to underground assets.

In recent years, a peak in faults in underground cable joints was experienced associated with high ambient temperatures and a combination of day to night cooling inducting faults in otherwise reliable assets. Ground movement can also pose a detrimental risk to underground assets.

Table 12: Climate risks posed to underground line, tunnels, and cable routes

Risk ID	Climate Hazard: Risk	ARP3 Impact Score	ARP3 Risk Score			ARP4 Impact Score	ARP4 Risk Score		
			2030	2050	2100		2030	2050	2100
AR4	Increased Temperature: Underground cable systems affected by the increase in ground temperature, reducing cable current (load) carrying capacity/ratings.	3	High 9	High 9	High 9	3	High 9	High 9	High 9
AR5	Summer Drought: Underground cable systems affected by summer drought and consequent ground movement, leading to mechanical damage/failure.	4	High 8	V High 12	V High 16	4	High 8	V High 12	V High 16
NG4	Sea Level Rise: A very small number of sites are potentially at increased risk if the level of current protection is not maintained or improved. (Due to the slow nature of sea level rise any cable identified at risk will either be protected or relocated prior to any system impacts; however, mitigation costs may be significant).	3	Med 3	High 6	High 9	3	Med 3	High 6	High 9

6.2.3 Transformers

Transformers are posed with direct risks of temperature change on the functioning of transformers, combined with the increased energy demand associated with temperature changes, such as increased cooling and heating requirements, which can result in overloading the transformers. Lightning is also an ever-constant risk; however, our network assets have lightning protection built in where currently required.

Table 13: Climate risks posed to transformers

Risk ID	Climate Hazard: Risk	ARP3 Impact Score	ARP3 Risk Score 2030	ARP3 Risk Score 2050	ARP3 Risk Score 2100	ARP4 Impact Score	ARP4 Risk Score 2030	ARP4 Risk Score 2050	ARP4 Risk Score 2100
AR7	Increase Temperature: Transformers affected by temperature rise, reducing rating. Increasing the operation of cooling fans and pumps fitted for transformers, increasing auxiliary losses	2	Med 6	Med 8	Med 10	2	Med 6	High 8	High 10
AR8	Increase Temperature: Transformers affected by urban heat islands and coincident air conditioning demand leading to overloading in summer months.	3	High 9	High 12	High 15	3	High 9	High 12	High 15
AR14	Lightning: Transformers affected by increased lightning activity.	2	Med 6	Med 8	Med 10	2	Med 6	Med 8	Med 10

6.2.4 Substation Sites (Including transformers, switchgear & earthing)

The highest risk posed to our 30,000 substation sites is associated with flooding: fluvial, pluvial, and coastal. The voltage and size of the substation determines the flood return period that it is built to be resilient to.

Grid and primary substations feeding 10,000-30,000 customers are protected against 1:1000 flood levels, those primary substations that have less than 10,000 recoverable customers are protected against 1:100/1:200 level, and secondary substations are retrospectively protected against flooding where regularly at risk or with vulnerable customers.[44] The real-world return periods of those flood levels are likely to decrease with climate change in the future, increasing the frequency of more severe flooding.

Table 14: Climate risks posed to substation sites

Risk ID	Climate Hazard: Risk	ARP3 Impact Score	ARP3 Risk Score 2030	ARP3 Risk Score 2050	ARP3 Risk Score 2100	ARP4 Impact Score	ARP4 Risk Score 2030	ARP4 Risk Score 2050	ARP4 Risk Score 2100
AR6	Summer Drought: Substation and network earthing systems adversely affected by summer drought conditions reducing the effectiveness of earthing systems.	2	Med 6	Med 6	Med 8	2	Med 6	Med 6	High 8
AR9	Increased Temperatures: Switchgear affected by temperature rise, reducing rating.	2	Med 6	Med 8	Med 10	2	Med 6	Med 8	High 10
AR10	Fluvial and Pluvial Flooding: Substations affected by river flooding due to increased winter rainfall, with loss or inability to function leading to reduced security of supply.	4	V High 16	V High 16	V High 20	4	V High 16	V High 16	V High 20
AR11	Fluvial and Pluvial Flooding: Substations affected by flash flooding due to severe rainfall, with loss or inability to function leading to reduced security of supply.	4	V High 12	V High 16	V High 20	4	V High 12	V High 16	V High 20
AR12	Sea level and storm surge: there is a risk that due to extreme sea flooding a substation may be lost or unable to function leading to reduced system security of	5	V High 15	V High 20	V High 25	5	V High 15	V High 20	V High 25

[44] SUB-01-018 SP Energy Networks Flood Resilience Policy, Issue No.3

	supply. A number of sites may be at risk from sea level rise/coastal erosion.								
AR13	Increased Precipitation: Substations affected by water flood from dam burst.	5	Med 1	High 2	High 2	5	5 Med	5 Med	5 Med

6.2.5 Vegetation Management

There are legislative obligations under the Electricity Safety, Quality and Continuity Regulations (ESQCR) associated with Overhead line conductor clearance including from vegetation. There are two elements to the risks associated with vegetation.

1. Increased precipitation and temperatures can prolong the growing season of vegetation, increasing the maintenance requirements.
2. Climate hazards i.e. floods, can also directly damage vegetation, moving vegetation within the clearance zones resulting in network faults.

These can depend upon vegetation density and species type. Although isolated events of vegetation induced risks have a low impact on our network, these can result in a cumulatively higher impact to network resilience. Our vegetation management programme is ongoing and the risk scores have not changed.

Table 15: Climate risks posed to vegetation management

Risk ID	Climate Hazard: Risk	ARP3 Impact Score	ARP3 Risk Score			ARP4 Impact Score	ARP4 Risk Score		
			2030	2050	2100		2030	2050	2100
VM1	Fluvial and Pluvial Flooding: Flooding events undermine tree roots, leading to additional faults due to falling trees.	3	High 6	High 9	High 12	3	High 6	High 9	High 12
VM2	Coastal Flooding: Flooding events undermine tree roots, leading to additional faults due to falling trees.	2	Med 4	Med 6	Med 8	2	Med 4	Med 6	Med 8
VM3	Drought events affect tree structure and stability	1	Low 3	Low 4	Low 4	1	Low 3	Low 4	Low 4
VM4	Ice and snow accumulation occur on trees leading to additional faults due to falling debris	2	Med 4	Med 6	Med 6	2	Med 4	Med 6	Med 6
VM5	Hurricane and high winds: Increased frequency of events may weaken trees leading to additional wind damage causing faults	2	Med 6	Med 8	Med 10	2	Med 6	Med 8	Med 10
VM6	Prolonged Growing Season: Increase in precipitation lead to an extended growing season and hence additional encroachment of vegetation.	2	Med 10	Med 10	Med 10	2	Med 10	Med 10	Med 10
VM7	Prolonged Growing Season: High raised temperatures leading to increased growth rates and the need for enhanced vegetation clearance and tree cutting schedules	2	Med 10	Med 10	Med 10	2	Med 10	Med 10	Med 10
VM8	Lightning: Increased lightning storms leading to increased number tree lightning strikes.	2	Med 6	Med 8	Med 10	2	Med 6	Med 8	Med 10
VM9	Drought: Change in water content of soil leads to changes in natural habitats of different species.	1	Low 3	Low 4	Low 4	1	Low 3	Low 4	Low 4

VM10	Pests, pathogens, and invasive species: Changes in weather conditions can allow pests, pathogens, and invasive species to appear in the UK, damaging trees leading to additional faults due to falling trees, for example, ash dieback.	2	Med 6	Med 8	Med 8	2	Med 6	Med 8	Med 8
VM11	Wildfire: Higher temperatures during summertime can create the conditions for wildfires that can affect trees and electrical infrastructure near them	3	Med 3	High 6	High 9	3	Med 3	High 6	High 9

6.2.6 Telecoms & Control Infrastructure

Infrastructure used to manage communications around the network are primarily at risk of flooding. A flood event can cause the entire site or equipment to become non-operational. Our flood programme is ongoing to protect any substation deemed to be at risk of flooding. Flooding is our highest risk to our network as such the scores have remained the same.

Table 16: Climate risks posed to control infrastructure

Risk ID	Climate Hazard: Risk	ARP3 Impact Score	ARP3 Risk Score			ARP4 Impact Score	ARP4 Risk Score		
			2030	2050	2100		2030	2050	2100
SP3	Fluvial, pluvial and sea flooding: Flooding impacts upon communication and control infrastructure. Whilst control centres are thought not to be at risk from flood, a site may become non-operational due to flooding potentially leading to a loss of system resilience or a loss of supply. Communications are also reliant upon third parties (Information communication technologies, ICT) who may also be impacted by an event.	3	High 9	High 12	High 15	3	High 9	High 12	High 15

6.3 Key Business Risks

These sections outline the business risks posed to how we operate associated with climate change.

6.3.1 Emergency Response and Planning

An increased frequency and severity of extreme events associated with climate change projections can increase the number of faults experienced and therefore the requirement for emergency response. How emergency events change in the future may require changes to be made to the planning and ultimately the capacity of the emergency response mechanisms we currently have in place.

Table 17: Climate risks posed to emergency response and planning

Risk ID	Climate Hazard: Risk	ARP3 Impact Score	ARP3 Risk Score			ARP4 Impact Score	ARP4 Risk Score		
			2030	2050	2100		2030	2050	2100
ER1	Ice: An increased frequency of events leads to an increased number of major incidents.	3	High 6	High 9	High 9	3	High 6	High 9	High 9
ER2	Snow: heavy snowfalls leading to excessive loading on buildings, and secondary risks from icing of equipment and road, leading to access issues in emergencies.	3	High 9	High 6	High 6	3	High 9	High 6	High 6
ER3	Hurricane & High Winds: Increased frequency and severity of extreme events causes additional faults leading to a strain on resources.	3	High 9	High 12	High 15	3	High 9	High 12	High 15
ER4	Snow and Ice: Increased heating demand causing additional loadings placed on network, leading to additional faults.	3	High 6	High 9	High 9	3	High 6	High 9	High 9
ER5	Increased number of lightning strikes lead to additional faults.	2	Med 6	Med 8	Med 10	2	Med 6	Med 8	Med 10
ER6	Increased Temperature: Increased cooling demand, causing additional loadings placed on network, leading to additional faults.	3	High 9	High 12	High 15	3	High 9	High 12	High 15
ER7	Heat Wave: High staff absence due to sickness leading to a reduced internal workforce	2	Med 4	Med 6	Med 8	2	Med 4	Med 6	Med 8
ER8	Slope and embankment failures causes additional faults and hampers staff movements leading to slow response times.	4	High 8	High 8	High 8	4	High 8	High 8	High 8

6.3.2 Routine Business

An increased number of faults across the network associated with climate change may reduce the capacity of the organisation to carry out routine business activities, such as maintenance, restoration, repairs, and capital investment. The risks are primarily associated with resources being diverted to attend to extreme events and the accessibility of the network either to carry out routine maintenance or respond and repair faults. Extreme events associated with multiple climate variables can impede access, such as flooding affecting access to faults on the network, and severe cold spells affecting the ability of our staff to travel around the network.

Table 18: Climate risks posed routine business

Risk ID	Climate Hazard: Risk	ARP3 Impact Score	ARP3 Risk Score			ARP4 Impact Score	ARP4 Risk Score		
			2030	2050	2100		2030	2050	2100
RB1	Fluvial and Pluvial: Increased number of substations at risk of flooding, leading to diversion of resources away from routine business	3	High 9	High 12	High 15	3	High 9	High 12	High 15
RB2	Coastal Flooding: Increased number of substations at risk of flooding, leading to diversion of resources away from routine business	3	High 9	High 12	High 15	3	High 9	High 12	High 15
RB3	Ice: Routine business suffers as a result of additional faults on the network.	2	Med 4	Med 6	Med 6	2	Med 4	Med 6	Med 6

RB4	Heavy Snow: heavy snowfalls leading to excessive loading on buildings, and secondary risks from icing of equipment and road, leading to access issues and disruption to operational activities	2	Med 4	Med 6	Med 6	2	Med 4	Med 6	Med 6
RB5	Hurricane & High Winds: Certain activities postponed due to safety concerns.	2	Med 6	Med 8	Med 10	2	Med 6	Med 8	Med 10
RB6	Heat Wave: Certain operational & non-operational activities postponed/delayed due to unsuitability of PPE for temperature conditions.	2	Med 4	Med 6	Med 6	2	Med 4	Med 6	Med 6
RB7	Fluvial and Pluvial: Risks to staff travelling to work from flooding of transport network. And Limiting ability to get to site to repair faults.	2	Med 6	Med 8	Med 10	2	Med 6	Med 8	Med 10
RB8	Cold Spells: Risks to staff travelling to work from cold spells and increase snow and ice on the transport network	2	Med 4	Med 6	Med 6	2	Med 4	Med 6	Med 6
SP1	Increased Temperatures: Maintenance programme may be impacted as increased temperatures may increase loads during summer reducing opportunity for planned outages and network reinforcement to enable maintenance. Temperature increases could thus lead to a possible reduction in the flexibility of the network (because of the change in load balance through the year).	3	High 9	High 12	High 15	3	High 9	High 12	High 15
SP2	Extreme Events: During extreme events teams may have limited safe access to isolate and repair faults. This could result in loss of supply to customers for a greater period of time.	2	Med 6	Med 8	Med 10	2	Med 6	Med 8	Med 10

6.3.3 Customer Service

Meeting customer service satisfaction requirements is a key priority of our organisation. Ofgem regulates the compliance of customer service requirements by stipulating the maximum response times of unplanned interruptions, appreciating that the frequency of certain climatic hazards can be unpredictable, but there should be adequate mitigation measures in place. Climate change shows an increase in severity and frequency of climate hazards which could slow down response times by impeding network access and affecting the health and safety of our staff and customers. The UK Net Zero carbon emissions by 2050 goal will likely increase electrical demand through increases in electrification of transportation, however at least the same levels of customer service will be needed.

Table 19: Climate risks posed to customer service

Risk ID	Climate Hazard: Risk	ARP3 Impact Score	ARP3 Risk Score			ARP4 Impact Score	ARP4 Risk Score		
			2030	2050	2100		2030	2050	2100
CS1	Fluvial & Pluvial Flooding: Increased number of substations at risk of flooding. Fault restoration times extended due to floodwaters.	3	High 9	High 12	High 15	3	High 9	High 12	High 15
CS2	Fluvial & Pluvial Flooding: Certain types of work prevented due to safety issues caused by office buildings flooding.	2	Med 6	Med 8	Med 10	2	Med 6	Med 8	Med 10
CS3	Coastal Flooding: Increased number of substations at risk of flooding. Fault restoration times extended due to floodwaters.	4	V High 12	V High 16	V High 20	4	V High 12	V High 16	V High 20
CS4	All Climate Hazards: Slow response times and increased fault durations due to large number of network faults and problematic access and travel.	2	Med 6	Med 8	Med 10	2	Med 6	Med 8	Med 10
CS5	Heavy Snow: Slow response times and increased fault durations due to large number of network faults and problematic access and travel.	2	Med 4	Med 6	Med 6	2	Med 4	Med 6	Med 6
CS6	Hurricanes & High Winds: Slow response times and increased fault durations due to a large number of network faults.	2	Med 6	Med 8	Med 10	2	Med 6	Med 8	Med 10
CS7	Heat Wave: Risks to staff travelling to work from high temperatures on public transport	2	Med 4	Med 6	Med 8	2	Med 4	Med 6	Med 8
CS8	Heat Wave: Vulnerable customers need additional prioritisation.	3	High 9	High 12	High 15	3	High 9	High 12	High 15
CS9	Cold Spells: Vulnerable customers need additional prioritisation.	3	High 9	High 6	High 6	3	High 9	High 6	High 6
CS10	Slope and Embankment Failures: Slow response times and increased fault durations due to large number of network faults and problematic access and travel.	3	High 6	High 6	High 6	3	High 6	High 6	High 6
CS11	Drought: Risks to public water supplies from drought and low river flows affecting workers in offices	2	Med 4	Med 6	Med 8	2	Med 4	Med 6	Med 8
CS12	Vector-borne Pathogens: High staff absence due to sickness leading to a reduced internal workforce.	3	High 9	High 9	High 9	3	High 9	High 9	High 9
CS13	Coastal Flooding: Certain types of work prevented due to safety issues caused by office buildings flooding.	4	V High 12	V High 16	V High 20	4	V High 12	V High 16	V High 20

7. Adaptation Tipping Points

Our strategy for climate resilience has been developed using the climate adaptation pathways approach[45] [46]. While this work was undertaken to develop our Climate Resilience Strategy (CRS) as part of our RIIO-ED2 business plan submission[47], the overarching strategy will be applied to the whole of SPEN, including SPT.

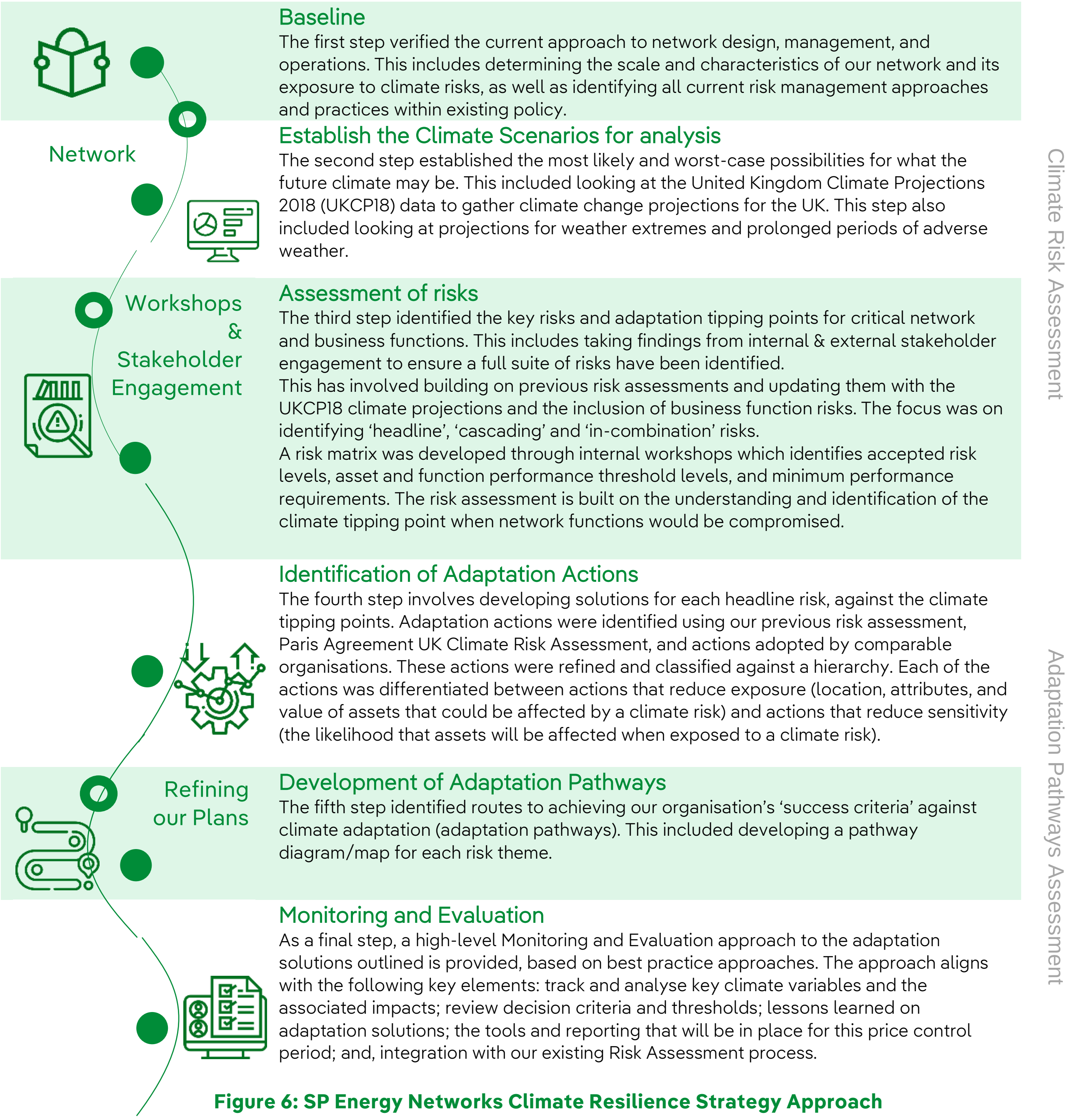

Figure 6: SP Energy Networks Climate Resilience Strategy Approach

The assessment is split into two stages; the Climate Risk Assessment, and the Adaptation Pathways Assessment, each of which has a set of series of steps and associated actions. The method taken is illustrated in Figure 6.

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[45] IEEE Power & Energy Society (2020). Technical Report – Resilience Framework, Methods, and Metrics for Electricity Sector. PES-TR83. The Institute of Electrical and Electronic Engineers. Inc.

[46] Haasnoot, M, et al., (2014). Dynamic adaptive policy pathways; A method for crafting robust decisions for a deeply uncertain world. Global Environmental Change 23. 485-298. Elsevier.

[47] https://www.spenergynetworks.co.uk/pages/our_riio_ed2_business_plan.aspx

An adaptation tipping point is reached when the magnitude of climate change is such that the current adaptation solution is no longer effective.

Three types of tipping points have been derived across two pre-defined categories:

- Stable State; where the formal objective / performance threshold of a solution (standards / laws) is exceeded,
- Mechanism; where accessibility, temporal or economic thresholds are surpassed[48].

These have been developed in order to better reflect the scope of the network and business risks, the three tipping points types as outlined within Table 20, echo both the qualitative and quantitative nature of the climate variables and the suite of assets / operational activity within the scope of SP Energy Networks.

Table 20: Adaptation Tipping Points

Type	Description	Example	Category
Climate Variable / Design Threshold	Applied where the climatic variable considered has a direct impact on the asset itself. Applied to high risks where possible.	Ambient air temperature that informs the maximum or minimum conductor temperature is exceeded.	Stable State
Response Led	Where climate variable/design threshold is not applicable, this is led by available data on SP Energy Networks activity and current approaches	An observed increase in time and cost spent on current vegetation management practices.	Mechanism
Outcome Led	Informed by associated impact of an event occurring (apply only to low risks where possible)	Heightened number of customer complaints and an increase in the duration of disruption from climatic events.	Mechanism

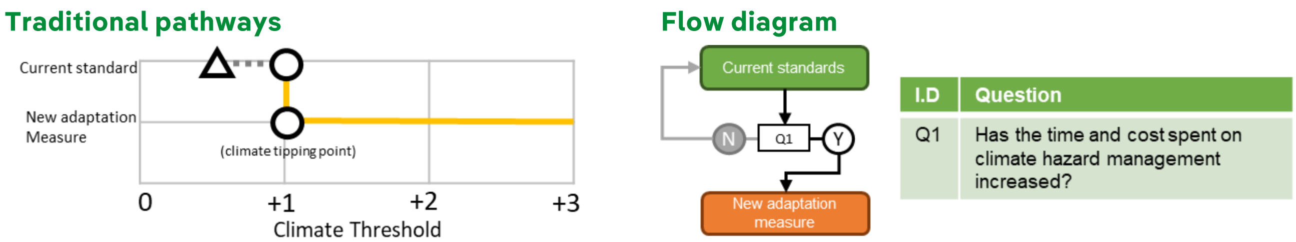
[48] Kees C H van Ginkel et al (2020). Environ. Res. Lett. 15 023001. Available at: https://iopscience.iop.org/article/10.1088/1748-9326/ab6395/pdf

8. Adaptation Solutions and Pathways

The following section presents the proposed adaptation solutions[49] which are organised into adaptation pathways[50] for each of the climate hazards. The solutions address the climate risks identified in Section 4 accounting for tipping points and climate change projection scenarios, with a view of building in climate resilience.

The solutions identified originate from several sources, including the 2015 Risk Assessment, interviews with key internal colleagues, and documentation from the Energy Network Association (ENA). They were updated or adjusted against the Risk Assessment carried out for the CRS and supplemented with findings from workshops.

Two styles of pathways diagrams have been developed (traditional pathways diagram and flow diagram) based upon the type of tipping point data available. Both follow a decision matrix format, and example diagrams are shown in Figure 7.



I.D	Question
Q1	Has the time and cost spent on climate hazard management increased?

Led by climatic tipping points *Response or outcome led, focused around questions*

Figure 7: Examples of traditional and flow diagram pathways

We have assigned the following style of diagram and assessment for each hazard based on which approach was better suited to the hazard identified, and the availability of corresponding decision points:

High temperatures; traditional pathways

Low temperatures; flow diagram

Flooding; flow diagram

Growing Season; flow diagram

Droughts; flow diagram

Storms & High Winds; flow diagram

Other risk; no pathways

The adaptation pathways approach enables moving between of adaptation solutions over time as new information and conditions emerge[51].

The solutions in the pathways are arranged by their ease of implementation, which relates to the level of work and resources required to deploy the solution, ranging from our current practices to changes in standards and design. Section 10 presents the proposed monitoring and evaluation approach to implement the climate adaptation pathways and are regularly reviewed.

[49] **Definition:** Actions to adapt to climate change
[50] **Definition:** Routes to achieve climate resilience
[51] Vandever,J., Bonham-Carter, C., Kapoor, A. (2021). Navigating Uncertain Futures with the Climate Adaptation Pathways Approach. Available at: https://naep.memberclicks.net/assets/newsletter/Newsletter2021/NAEP%20Winter%202021%20Article%20Navigating%20Uncertain%20Futures.pdf

8.1 High Temperatures

The expected increase in annual, minimum, and maximum air temperatures across all seasons poses a number of risks, including reduced ratings of transformers, switchgear and cables, and additional faults on our network caused by increased loadings from high cooling demand.

Figure 8 presents different pathways of adaptation actions that we would apply to reduce the sensitivity or the exposure of our assets.

Pathways have been established for two climate scenarios, RCP6.0 and RCP8.5, to illustrate when changes in the UK's maximum summer average temperature would be met under different possible futures. The associated time periods for each of the expected changes in temperature are displayed along the x-axis of the diagram.

All pathways begin in the middle of the diagram with the current policies (shown in yellow text).

Actions reducing sensitivity are displayed above the current policy, and actions that reduce exposure are displayed below.

The circles represent the maximum summer average temperatures that are assumed to trigger a change to new adaptation actions. For example, it is assumed that reaching the maximum summer average temperature of 20ºC will trigger us to incorporate comprehensive changes in our network, especially accelerating its efforts to update legacy assets.

The triangles show which maximum summer average temperatures are assumed to trigger a decision point to incorporate the corresponding new adaptation action.

It is common that after a decision is made there is a lead time until the decision can be implemented, represented in the diagram by a dotted line between the triangles and circles. As an example, it is assumed that the maximum temperature reaching around 21ºC will trigger the decision to adopt new transformer technologies, but it is assumed that this action will only be implemented once the maximum temperature reaches around 22ºC.

In this diagram, the only action that has a tipping point (that is, when the action stops being effective) is keeping legacy assets built to old specifications. Its tipping point has a question mark as it is uncertain when all of these assets will be changed. The rest of actions are assumed to reach their tipping points at higher temperatures than the ones plotted in the diagram. That is why their pathways end in arrows.

Finally, the pathways are colour coded according to the network functions that each action affects.

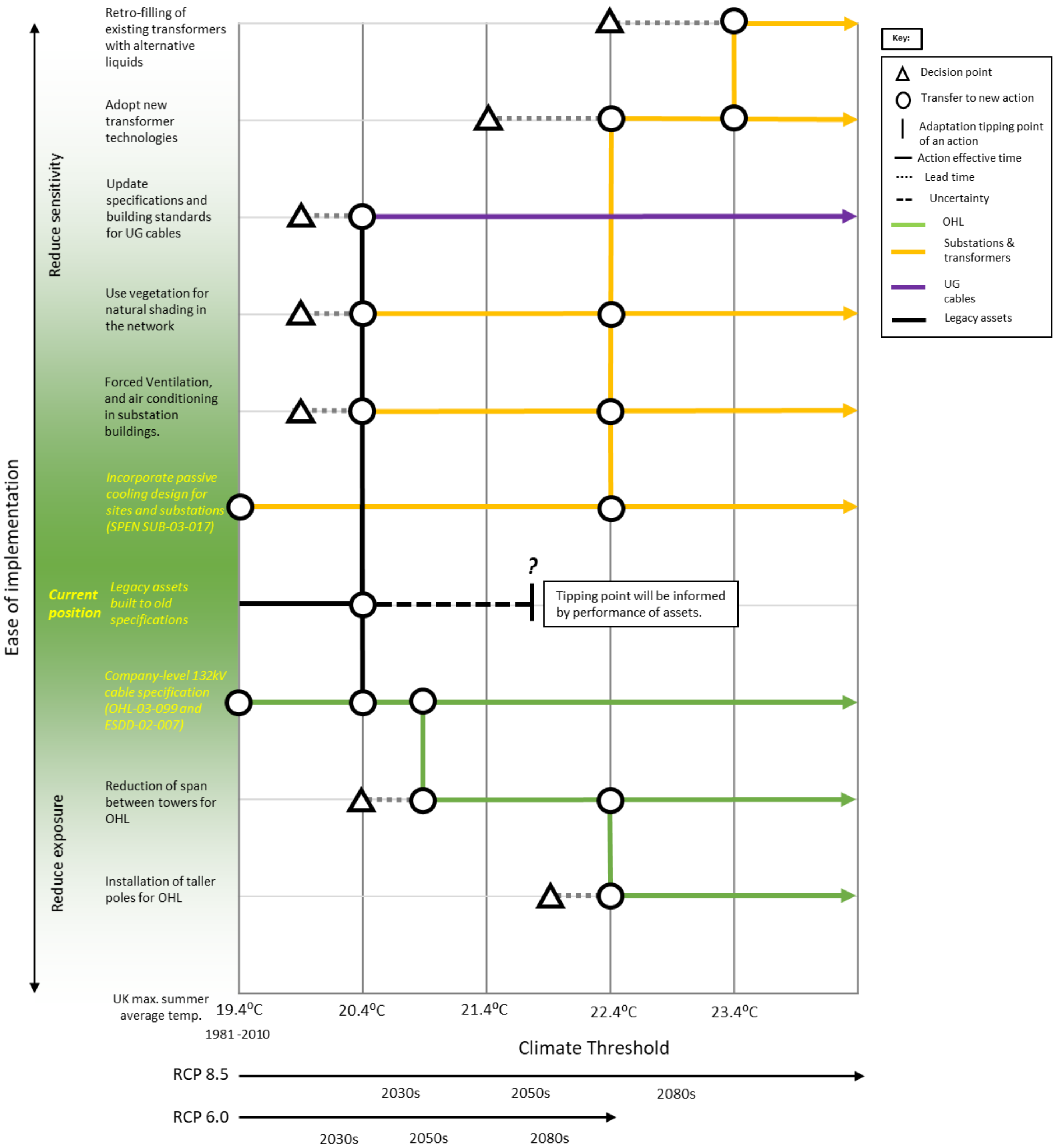
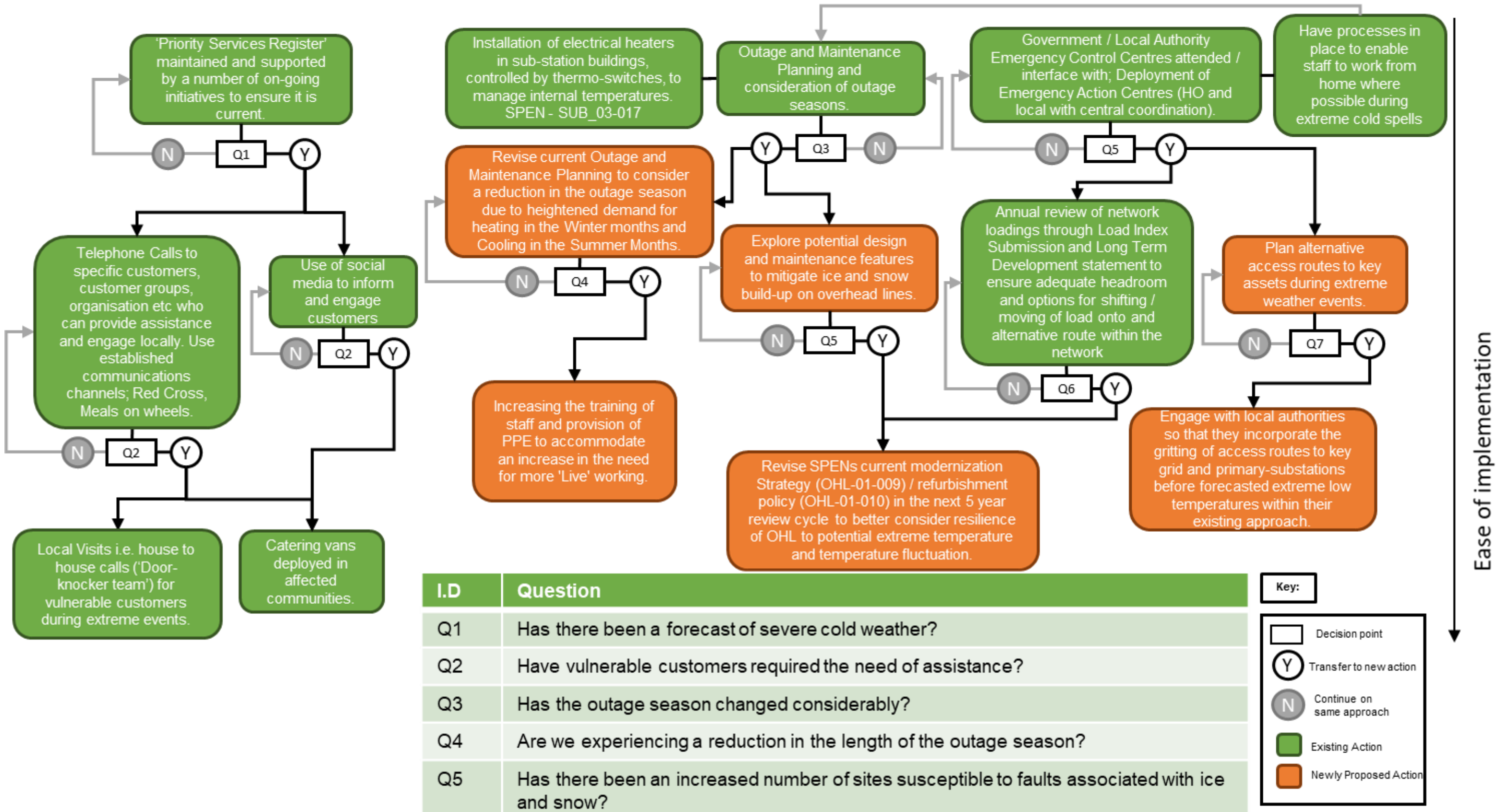


Figure 8: Traditional adaptation pathways diagram for dealing with high temperatures

8.2 Low Temperatures

As discussed in Section 4.2.1, it is likely that colder temperatures will become less frequent, however extreme events will still occur and it is important to plan for them. Prolonged cold spells may lead to additional network faults due to additional loadings caused by increased heating demand. Also, heavy snow events and snow build up may cause travel disruptions for staff, and large numbers of additional network faults may lead to slow response times and cause routine business to suffer. Figure 9 below outlines the adaptation solutions for low temperatures.

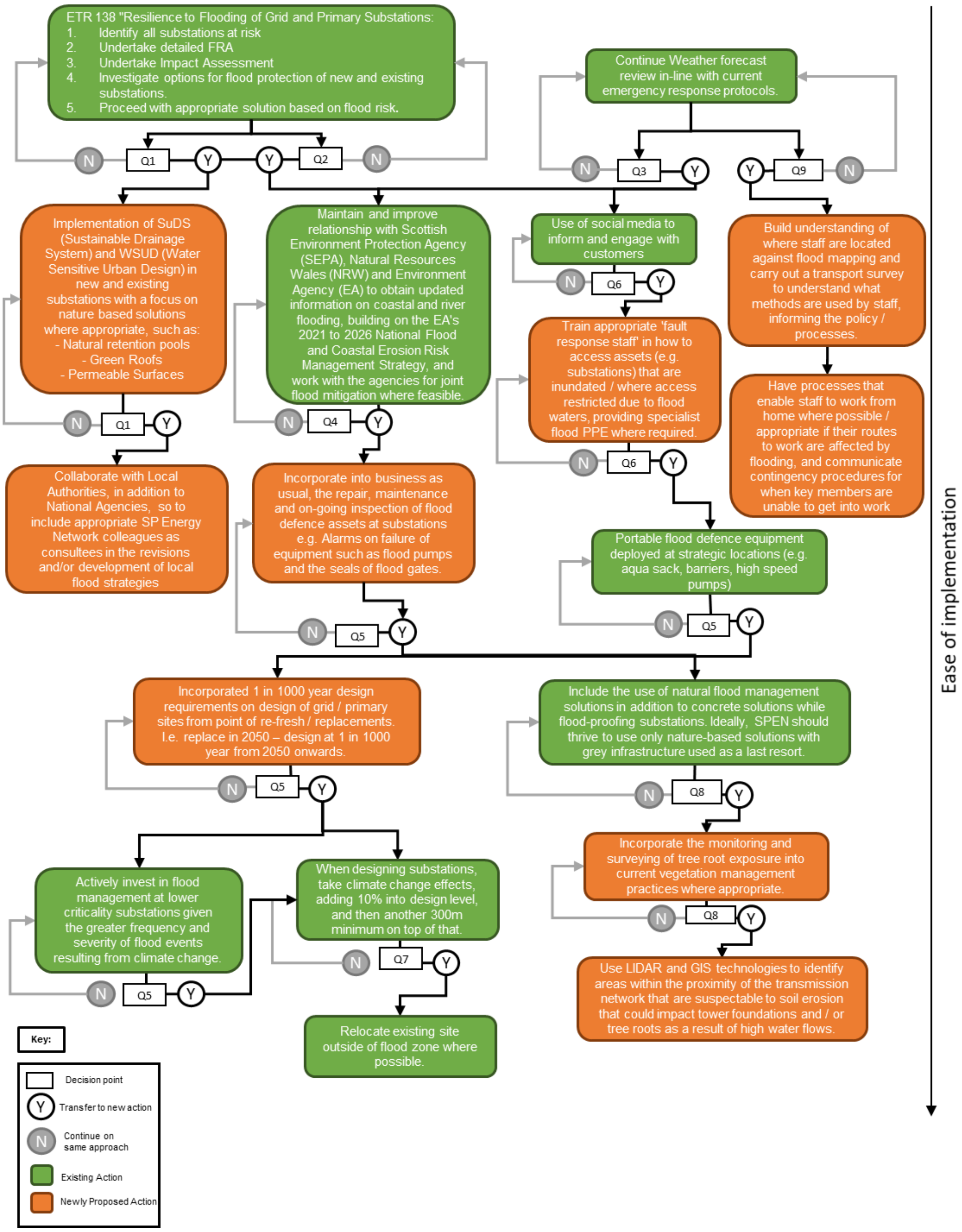


I.D	Question
Q1	Has there been a forecast of severe cold weather?
Q2	Have vulnerable customers required the need of assistance?
Q3	Has the outage season changed considerably?
Q4	Are we experiencing a reduction in the length of the outage season?
Q5	Has there been an increased number of sites susceptible to faults associated with ice and snow?
Q6	Have alternative routes within the network for shifting / moving of load been exhausted or not found?
Q7	Have we observed that main and alternative access routes to key assets during extreme weather events are frequently not free of snow or ice?

Figure 9: Flow diagram for climate adaptation pathways approach for dealing with low temperatures

8.3 Flooding

Climate change projections show increases in extreme winter precipitation in the future. This increases the risk of fluvial and pluvial flooding affecting our network, extending fault restoration times, and diverting resources away from routine business operations. Other risks from flooding include transport disruptions for staff travelling to work and falling trees due to tree roots being undermined. Figure 10 below outlines the adaptation solutions for these flooding risks.

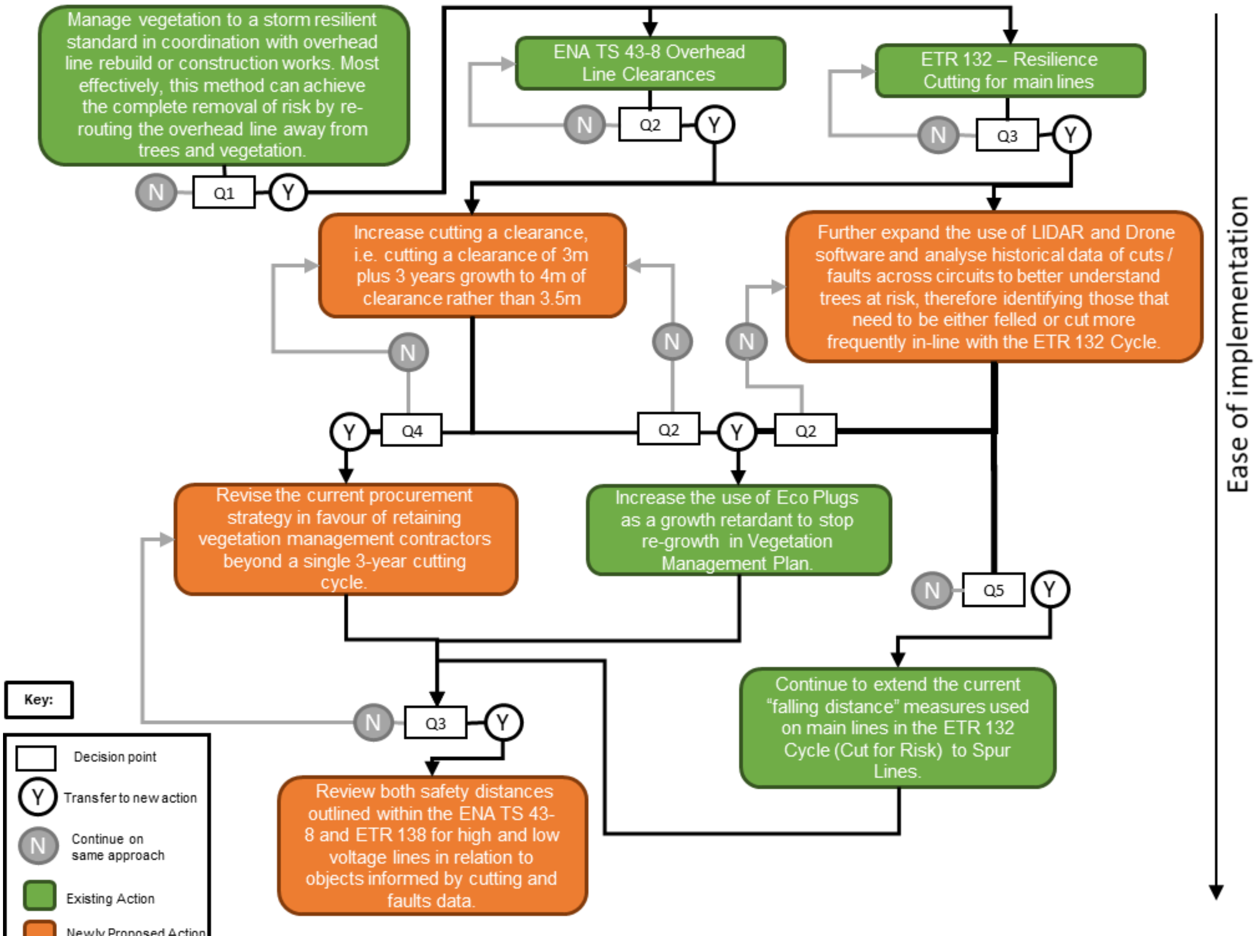


I.D	Question
Q1	Have we experienced an increase in surface flood events?
Q2	Have we experienced an increased frequency and severity of flood events?
Q3	Has a flood warning been issued?
Q4	Have we experienced any failures of flood defences?
Q5	Are the flood defences no longer effective in mitigating the identified impact?
Q6	Was there a heightened number of faults with unacceptable outage timeframes?
Q7	Are the flood defences no longer effective in protecting grid and primary substations
Q8	Has there been an increased amount of falling trees during a flood event?
Q9	Have we experienced any flood events that affected the ability of staff getting into work?

Figure 10: Flow diagram for climate adaptation pathways approach for dealing with flooding

8.4 Growing Season

As previously discussed in this report, a prolonged growing season due to higher temperatures associated with climate change may create risks for SP Energy Networks. Risks include the interference and encroachment of vegetation, affecting overhead lines. Figure 11 below outlines the adaptation solutions for risks from a prolonged growing season.

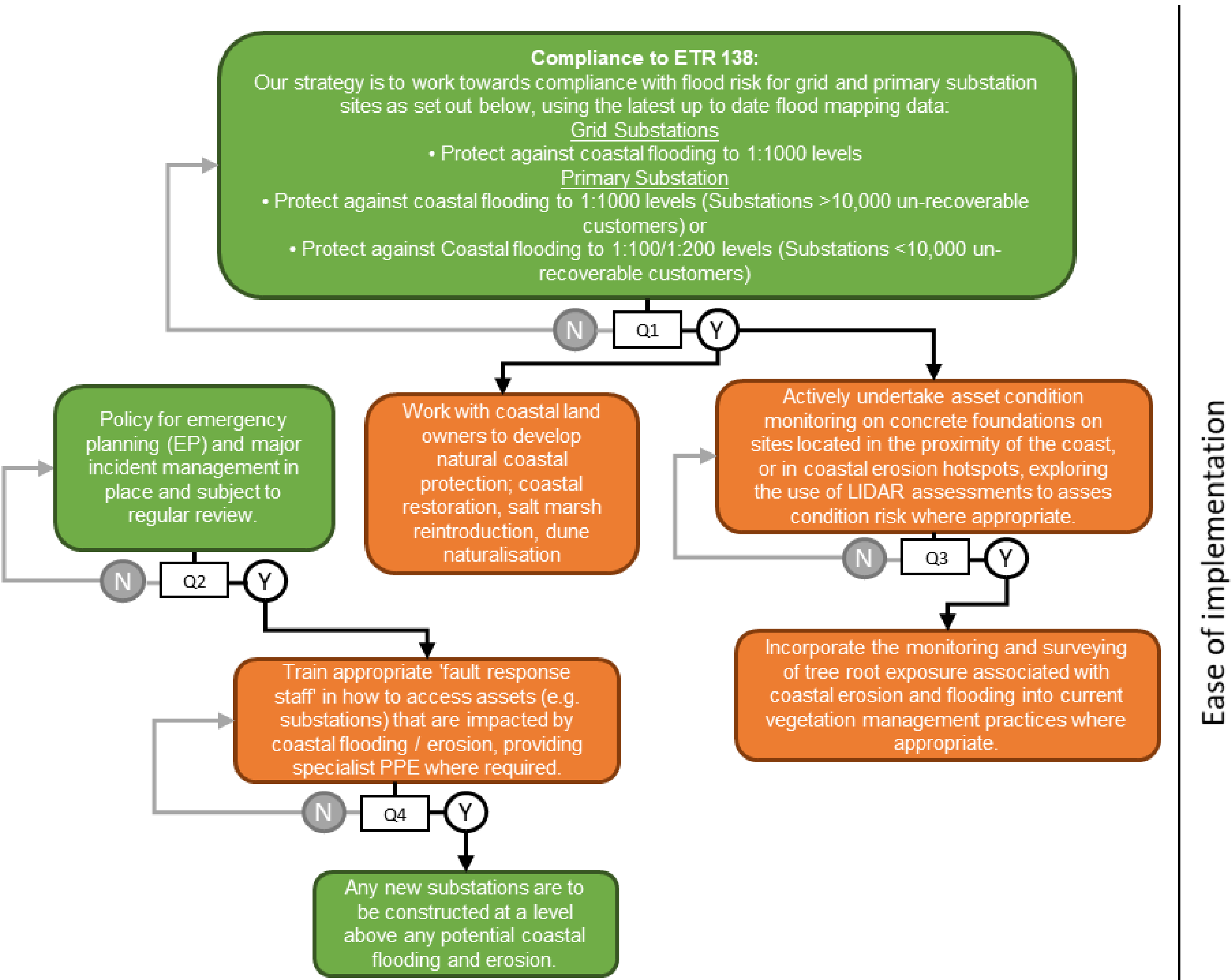


I.D	Question
Q1	Is vegetation encroaching on newly built lines, and therefore required maintenance?
Q2	Are we experiencing faster vegetation growth, and are we therefore needing to cut more frequently and extensively?
Q3	Is the data demonstrating more frequent tree fall related faults on OHL?
Q4	Is it costing more time and money for our contactors to undertake cutting cycles?
Q5	Are Spur lines experiencing a greater number of tree fall related faults?

Figure 11: Flow diagram for climate adaptation pathways approach for dealing with increased vegetation growing season

8.5 Sea Level Rise

Projected mean sea level rise of up to 1 m by the end of the century may impact a number of our sites and cause them to be non-operable due to inundation or erosion. The increased frequency and severity of extreme tidal surge events also has the potential to affect the ability of a substation to function, leading to reduced system security of supply. Figure 12 below outlines the adaptation solutions for sea level rise.



I.D	Question
Q1	Have we experienced an increased rate of coastal erosion?
Q2	Was there a heightened number of faults with unacceptable outage timeframes?
Q3	Has there been an increased amount of falling trees during a coastal flood event?
Q4	Are sea levels exceeding the current coastal defences?

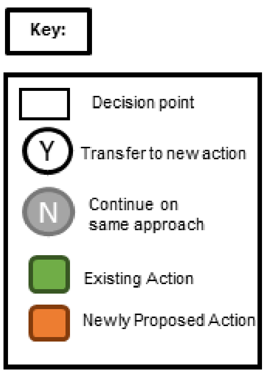
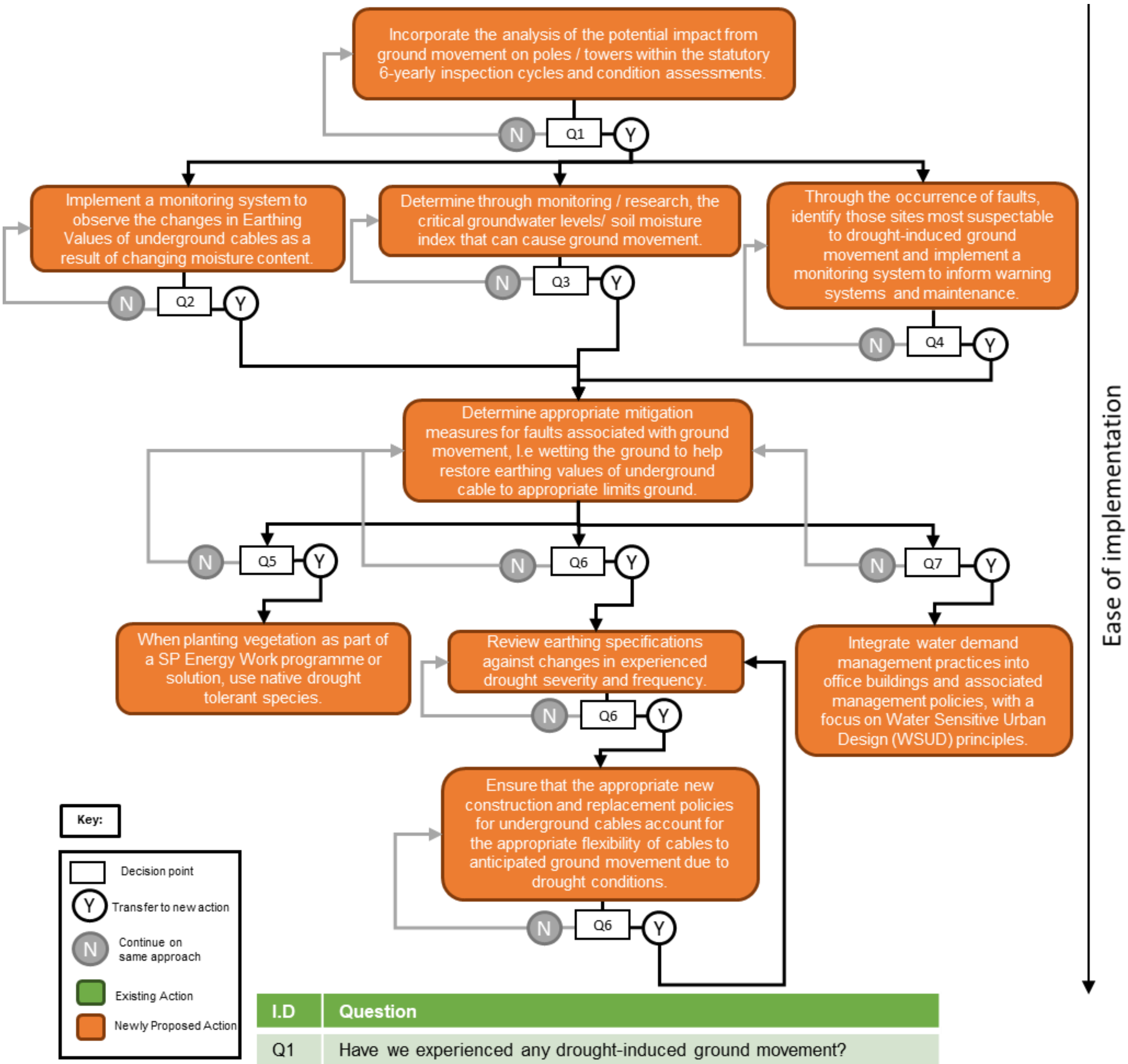


Figure 12: Flow diagram for climate adaptation pathways approach for dealing with sea level rise

8.6 Drought

Climate change projections show a decrease in summer precipitation, increasing the likelihood of drought and the risks of earth and ground movement on our assets. Currently, we have no specific drought mitigation strategy and so all the adaptation actions are classed as new. Figure 13 below outlines the adaptation solutions for drought.

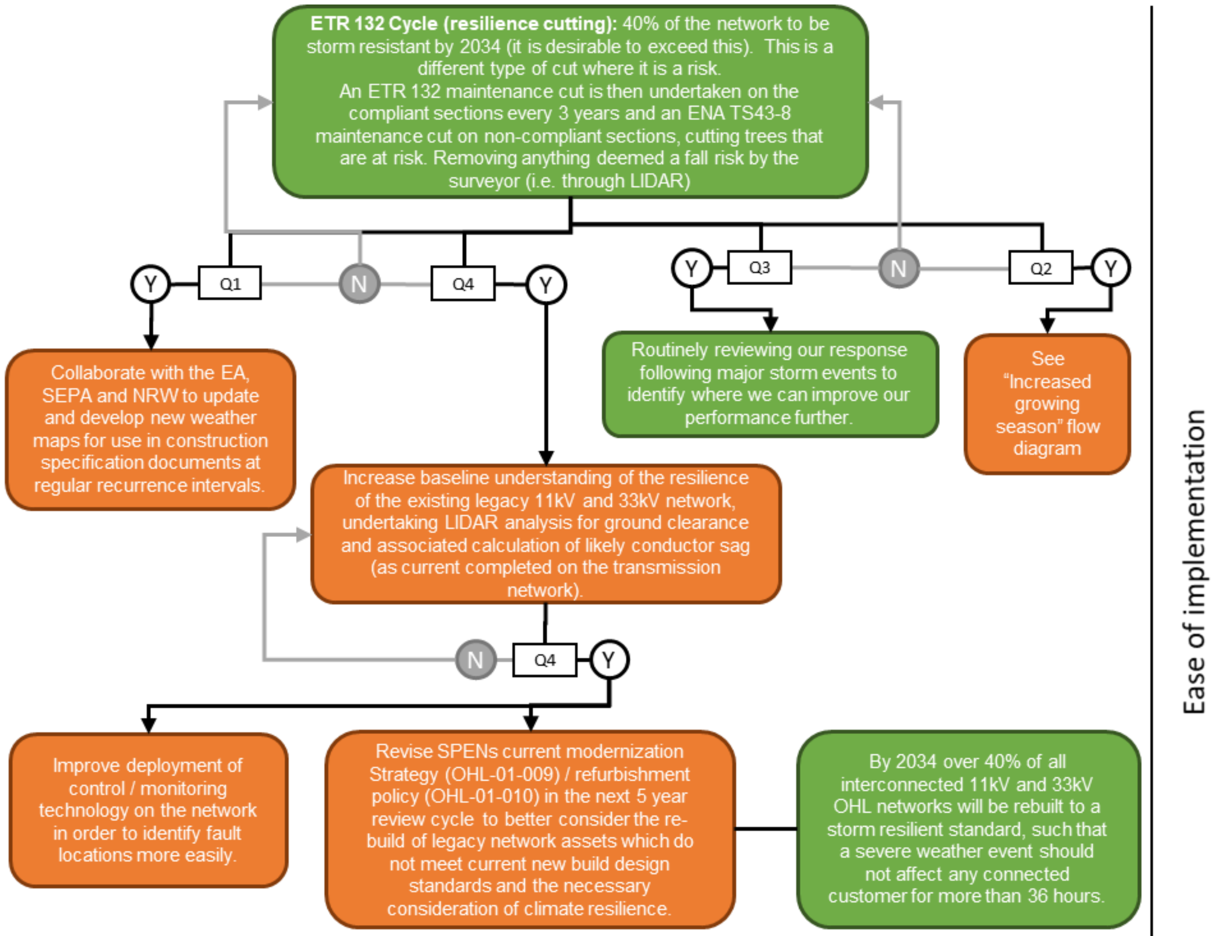


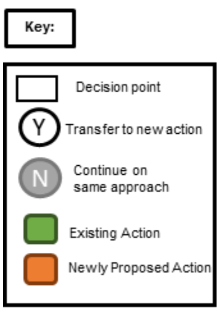
I.D	Question
Q1	Have we experienced any drought-induced ground movement?
Q2	Has there been a significant change in moisture content, resulting in underground cable faults?
Q3	Have critical groundwater levels been met, causing ground movement?
Q4	Has there been an increased number of sites susceptible to faults associated with drought?
Q5	Have we noticed a decrease in biodiversity?
Q6	Have we experienced an increased amount of drought events, and an increased number of faults as a result?
Q7	Have we experienced any water shortages?

Figure 13: Flow diagram for climate adaptation pathways approach for dealing with drought

8.7 High Winds and Storms

UKCP18 projections show an increase in near surface wind speeds over the UK for the second half of the 21st century during the winter season, with some climate models displaying large peaks in some years. Although there is interannual and decadal variance of windstorms and uncertainty in future storm intensities, it is still vital to be prepared for such events. Risks to SP Energy Networks include large numbers of network faults, leading to slow response times, strain on resources and the postponement of work due to safety concerns. Figure 14 below outlines the adaptation solutions for storms and high winds.





I.D	Question
Q1	Are we experiencing storm events that do not correlate with the existing weather maps?
Q2	Are we experiencing a greater number of faults due to tree-falls during storm / high wind events?
Q3	Was there a heightened number of faults with unacceptable outage timeframes?
Q4	Are we experiencing an increased number of faults on the existing legacy 33KV network?

Figure 14: Flow diagram for climate adaptation pathways approach for dealing with storms and high winds

8.8 Other Risks

Finally, there are a number of other climate-related risks and hazards which are not included in the categories above. These are lightning, pests and pathogens, wildfires, and embankment failures. As these risks are not in line with a specific climate variable and the solutions are not inter-linked through common response or outcome led tipping points, neither a pathway nor flow diagram has been produced. Solutions have been categorised according to their adaptation type, depending on the stage in the process that they fall under (planning, design, standards/specifications, monitoring, or engagement), and whether they reduce exposure or sensitivity. Any solutions which are Nature-Based Solutions[52] are highlighted. Table 21 defines these categories.

Table 21: Definition of categorisation of adaptation solutions

Term	Definition
Reduce Exposure	Changing the location, attributes, and value of assets that could be affected by a climate risk
Reduce Sensitivity	Reducing the likelihood that assets will be affected when exposed to a climate risk
Adaptation Type	Planning: Determining the level of risk, and developing plans to set out the approach to deal with the climate risk Monitoring: Assessing how the risk changes over time, and any external factors such as load patterns Standards/Specifications: Specific requirements Design: Structural changes Engagement: Communication approach with key stakeholders
Nature-Based Solution	Any solutions using natural approaches have been indicated with this symbol:

For each adaptation solution, it's alignment with the SP Energy Networks sustainable business strategy and six sustainability drivers has been indicated in the solutions table using the icons displayed in Figure 15, while proposed solutions for other risks are presented below in Table 22.

Figure 15: SP Energy Networks Sustainable Business Strategy Sustainability Drivers

[52] Nature-Based Solutions are defined by the IUCN as "actions to protect, sustainably manage, and restore natural or modified ecosystems, that address societal challenges effectively and adaptively, simultaneously providing human well-being and biodiversity benefits". https://www.iucn.org/commissions/commission-ecosystem-management/our-work/nature-based-solutions

Table 22: Adaptation solutions for lightning, all risks, pandemics, slope instability and wildfires

Adaptation solution	Risk ID	Sustainability Driver
Lightning Design: By 2034 over 40% of all interconnected 11kV and 33kV OHL networks will be rebuilt to a storm resilient standard, such that a severe weather event should not affect any connected customer for more than 36 hours.	AR14a	
Lightning Design: Improved lightning protection including earthing and, surge arresters on plant, and other equipment and automated procedures will be considered if lightning strike frequency increases.	AR14b	
Lightning Design: Introducing increasing numbers of reclosers and remotely operated switchgear, which allow electrical faults to be isolated and the network reconfigured remotely	SP2	
Lightning Monitoring: Routinely reviewing our response following major storm events to identify where we can improve our performance further.	ER5	
All Risks Engagement: Use of social media to inform and engage customers.	CS4	
Pandemics Planning: Pandemic strategy; Have processes in place to enable staff to work from home where possible.	CS12	
Slope Failures Monitoring: Monitor weather for seasonal prolonged wet and drying periods which increase the likelihood of slope failures.	ER8 CS9	
Slope Failures Design: Identify locations that are susceptible to slope failure and work with appropriate stakeholders and landowners to implement mitigating solutions, for example, planting trees with strong root structures to stabilise the slope.	ER8 CS10	
Pest Monitoring: Incorporate the detection of invasive species into existing vegetation management approaches and work with relevant stakeholders to inform and also develop options for mitigating against the invasive species.	VM0	
Wildfire Planning: Use LIDAR and GIS technologies, working with appropriate stakeholders (such as Forestry Commission, EA, NRW) to identify and map areas at greater risk to wildfires to help inform appropriate management activities.	VM1	
Wildfire Monitoring: Incorporate the removal of dry vegetation litter/fuel build up during periods of high temperatures into current Vegetation Management practices/cutting cycles.	VM1	

9. Future Activity

One of the challenges with ensuring our network is resilient to climate change is the uncertainty in the climate change predictions. Applying the adaption pathways approach to our operational activities allows us to monitor our existing activity against different climate change scenarios and find the balance between building resilience and over-investment. The adaption pathways highlight tipping points, which are reached when the magnitude of climate change is such that the current adaption solution is no longer effective, and the course of action must be changed.

The areas identified with the highest Climate Hazard Risk (Section 6) have been evaluated against the future pathways process (Sections 7 and 8) and the future tipping points established in each case. The outcome of this analysis has determined the actions we must now take to ensure that we build a network that is resilient to future climate change, and the trigger points for future actions are identified. This analysis is presented in Table 23.

Table 23 Applying the adaption pathways approach to our network

Risk ID	Climate Hazard: Risk	Impact Score	Risk Score RCP 8.5 2030	Tipping Point Analysis	Resulting Action
AR5	Summer Drought: Underground cable systems affected by summer drought and consequent ground movement, leading to mechanical damage/failure.	4	High 8	Tipping point is at Q1: have we experienced any drought induced ground movement?	Incorporate the analysis of the potential impact from ground movement on poles / towers within the statutory 6-yearly inspection cycles and condition assessment.
AR10	Fluvial and Pluvial Flooding: Substations affected by river flooding due to increased winter rainfall, with loss or inability to function leading to reduced security of supply.	4	V High 16	Tipping point is at Q5: when existing flood mitigation measures stop being effective.	ETR 138 - Resilience to Flooding of Grid and Primary Substations: Identify all substations at risk, undertake detailed FRA and impact assessment; investigate options and proceed with appropriate solution.
AR11	Fluvial and Pluvial Flooding: Substations affected by flash flooding due to severe rainfall, with loss or inability to function leading to reduced security of supply.	4	V High 12	Tipping point is at Q5: when existing flood mitigation measures stop being effective.	ETR 138 - Resilience to Flooding of Grid and Primary Substations: Identify all substations at risk, undertake detailed FRA and impact assessment; investigate options and proceed with appropriate solution.
AR12	Sea level and storm surge: there is a risk that due to extreme sea flooding a substation may be lost or unable to function leading to reduced system security of supply. A number of	5	V High 15	Tipping point is at Q1: have we experienced an increased rate of coastal erosion?	Strategy is to work towards compliance with ETR138: protect against flooding to 1:1000 levels for Grid substations and Primary substations >10k un-recoverable customers, or 1:100/1:200

	sites may be at risk from sea level rise/coastal erosion.[1]				levels for substations <10k unrecoverable customers
CS3	Coastal Flooding: Increased number of substations at risk of flooding. Fault restoration times extended due to floodwaters. [1]	4	High 8	Tipping point is at Q1: have we experienced an increased rate of coastal erosion?	Strategy is to work towards compliance with ETR138: protect against flooding to 1:1000 levels for Grid substations and Primary substations >10k un-recoverable customers, or 1:100/1:200 levels for substations <10k unrecoverable customers
CS13	Coastal Flooding: Certain types of work prevented due to safety issues caused by office buildings flooding. [1]	4	V High 12	Tipping point is at Q1: have we experienced an increased rate of coastal erosion?	Strategy is to work towards compliance with ETR138: protect against flooding to 1:1000 levels for Grid substations and Primary substations >10k un-recoverable customers, or 1:100/1:200 levels for substations <10k unrecoverable customers

A more detailed description of these actions is provided in the following sub-sections. Further detailed information on all of the proposed investment can be found within the Engineering Justification Papers submitted as part of our RIIO-T3 and RIIO-ED2 business plan submissions, and the Environmental Action Plans (EAPs) for each.

9.1 Flood Mitigation

SPT currently owns and operates 166 substations at voltages ranging from 132kV up to 400kV. Within the RIIO-T2 period we invested £5.5m in flood mitigation to protect 10 substations (seven 132kV substations, three 275kV substations) where flood mitigation was deemed necessary.

During the development of our RIIO-T3 business plan we have carried out further flood mapping surveys at all our transmission substations. Of these 166 sites a small percentage are at risk from sea level rise and coastal flooding. The substations are mainly impacted by climate risks related to extreme precipitation such as fluvial and pluvial flooding. As such we are proposing to invest a further £11.5m in substation flood mitigation during RIIO-T3 across our 132-400kV transmission network[53].

For distribution we are still in the RIIO-ED2 period and we are currently investing £9.65m (£5.30m in SPD and £4.34m in SPM) in flood mitigation at our substation's locations. This includes the undertaking of 328 detailed flood risk assessments at sites identified as being at risk based on the latest flood mapping by the environment agencies and forecast flood mitigation works will be required at 105 of these locations. This work is still ongoing which will improve our resilience to flooding in the future.

Our flood mitigation works contribute to mitigating the following risks identified within this document:

- AR10 - Fluvial and Pluvial Flooding: Substations affected by river flooding due to increased winter rainfall, with loss or inability to function leading to reduced security of supply.

[53] https://www.spenergynetworks.co.uk/pages/riio_t3_business_plan.aspx

- AR11 - Fluvial and Pluvial Flooding: Substations affected by flash flooding due to severe rainfall, with loss or inability to function leading to reduced security of supply.
- AR12 - Sea level and storm surge: there is a risk that due to extreme sea flooding a substation may be lost or unable to function leading to reduced system security of supply. A number of sites may be at risk from sea level rise/coastal erosion.

9.2 Overhead Line Storm Resilience

During RIIO-ED2 we are undertaking an extensive programme of OHL modernisation (£208m) which includes a 171km of EHV and 1,117km of HV OHL re-build in accordance with latest storm resilient standards. The overhead line re-build programme shall be in compliance with ETR132 Specification (storm resilience vegetation management). The overall programme shall provide benefits in mitigating the below risks identified within this strategy.

- AR3 - Prolonged growing season: Overhead lines affected by interference from vegetation.
- AR15 - Hurricanes & High Winds: Overhead line structures affected by wind speeds not accommodated for in design.

9.2.1 Storm Arwen Re-opener

In the wake of Storm Arwen which caused widespread disruption in November 2021, a review was set up to consider what TNOs and DNOs could do to be better prepared should such a storm occur again. On the back of this review Ofgem gave DNOs the opportunity to submit additional proposals above their RIIO-ED2 business plan to allow work on storm resilience to commence in this window. SPEN submitted our proposals on 31st January 2024, with the final determination by Ofgem published 9th December 2024. This re-opener has provided us with a further £22m of targeted funding to enable us to prepare our network to be more resilient in the face of any future storm activity. Delivering this investment will ultimately reduce the likelihood of faults during storms and speed up supply restoration when power cuts do happen.

Our proposals include:

- Remove individual weak HV poles not yet due for circuit modernisation,
- Develop a digital model of our OHL network to simulate weather events and identify weaknesses,
- Deploy interconnecting circuits between DNO licence areas, which will improve network redundancy,
- Installation of permanent generator connection points to reduce restoration times to as many of our customers from a single generator.

9.3 Vegetation Management

Within RIIO-ED2 we have continued to deliver our Tree Cutting Programme (CV29) which has a forecast expenditure of £82.02m (£23.82m in SPD and £58.20m in SPM) over the 5-year period. Within RIIO-ED2 our tree-cutting expenditure has increased slightly to maintain our RIIO-ED1 cyclic-cutting programme in-light of our latest framework costs and the increased growth rates identified in VM6 and VM7.

During RIIO-T3 we are looking to double our Vegetation Management budget which will bring our expenditure to £0.99m per annum.

By continuing this programme of vegetation management and adapting to changes in growth rates as they occur within our cyclic programmes of cutting, we shall provide benefit in mitigating the below risks identified within this strategy.

VM1 Fluvial and Pluvial Flooding: Flooding events undermine tree roots, leading to additional faults due to falling trees. This has been described as a high-risk factor.

VM2 Coastal Flooding: Flooding events undermine tree roots, leading to additional faults due to falling trees. This has been described as a medium-risk factor.

VM3 Drought: Events affect tree structure and stability. This has been described as a low-risk factor.

VM4 Ice and Snow: Accumulation occurs on trees leading to additional faults due to falling debris. This has been described as a medium-risk factor.

VM5 Hurricane and High Winds: Increased frequency of events may weaken trees leading to additional wind damage causing faults. This has been described as a medium-risk factor.

VM6 Prolonged Growing Season: Increase in precipitation lead to an extended growing season and hence additional encroachment of vegetation. This has been described as a medium-risk factor.

VM7 Prolonged Growing Season: High raised temperatures leading to increased growth rates and the need for enhanced vegetation clearance and tree cutting schedules. This has been described as a medium-risk factor.

VM8 Lightning: Increased lightning storms leading to increased number tree lightning strikes. This has been described as a medium-risk factor.

VM9 Brought: Change in water content of soil leads to changes in natural habitats of different species. This has been described as a low-risk factor.

VM10 Pests, Pathogens, and Invasive Species: Changes in weather conditions can allow pests, pathogens, and invasive species to appear in the UK, damaging trees leading to additional faults due to falling trees, for example, ash dieback (see Section 6.2.5). This has been described as a medium-risk factor.

VM11 Wildfire: Higher temperatures during summertime can create the conditions for wildfires that can affect trees and electrical infrastructure near them. This has been described as a high to medium risk factor.

9.4 Climate Change Resilience Metric

As part of RIIO-ED2 price control development, and the ongoing draft RIIO-T3 submission Ofgem have requested that companies develop a Climate Change Resilience Metric (CRM). Ofgem are working with companies to support the development of their individual CRMs. Companies are also being asked to identify the more long-term climate change impacts that could affect the networks through collaborating with the Energy Network Association (ENA) working group.

CRMs will help to provide a common fall-back for climate principles and key topics, allowing the Climate Change Resilience Working Group to focus on developing a collective CRM. Our draft of the CRM (2024) has helped to develop and guide the industry wide CRM.

The following climate variables: Precipitation, Sea level rise, Coastal erosion & flooding, Temperature and Storm & wind events, are listed in the CRM document as the "…umbrella grouping of weather and climate factors that contribute to hazards and risks to energy infrastructure.'.

9.5 Climate Resilience Demonstrator (CReDo)

SP Energy Networks are a partner in the Climate Resilience Demonstrator (CReDo)[54] project. CReDo is a pioneering climate change adaptation digital twin project that provides a practical example of how connected data can improve climate adaptation and resilience across a system of systems.

CReDo looks specifically at the impact of flooding on energy, water and telecoms networks. It demonstrates how those who own and operate them can use secure, resilient, information sharing across sector boundaries to mitigate the effect of flooding on network performance and service delivery.

SP Energy Networks hope that by using the benefits of this joined up approach that this will help us to identify areas of greater interdependence so that we can make more informed investment decisions to support national infrastructure.

[54] https://digitaltwinhub.co.uk/climate-resilience-demonstrator-credo/

10. Monitoring and Evaluation

This section outlines the framework for Monitoring and Evaluation (M&E) that we will put into place to ensure that the pathways outlined as part of our Climate Resilience Strategy are appropriately implemented.

M&E is a fundamental pillar of the adaptation pathways approach, the processes of which work together to assess the performance of an intervention over time. Effective M&E is an essential part of our CRS and can inform best use of resources, increase understanding of changing risks, and inform decision making and investment.

Monitoring refers to the on-going analysis of the progress of actions as they are being implemented to ensure they are proceeding as planned.

Evaluation is the periodic assessment of the results of monitored resilience actions.

10.1 Roles and Responsibilities

The following roles and associated responsibilities have been identified for internal allocation/appointment within SP Energy Networks as part of the M&E framework, beginning formally prior to RIIO-ED2.

A Resilience Coordinator has been appointed internally and holds the following role:

- To oversee the implementation of the appropriate pathways and application of the M&E approach,
- Help identify Resilience Champions (see below) who will advocate for resilient outcomes in each of the Function categories,
- Collaborate with Resilience champions to ensure proper progress in monitoring and evaluation is completed,
- Coordinate the production of the appropriate reporting requirements; and,
- Communicate with the internal Business Assurance Team to incorporate climate risks into our current Enterprise Risk Management Framework.

Resilience Champions: For each function category identified within the CRS, an internal Resilience Champion has been identified. These individuals are responsible for monitoring and implementing the M&E process for their function category. Reporting to the Resilience Coordinator, Resilience Champions determine appropriate stakeholders within the business for data collection and are responsible for compiling and developing the appropriate reporting content for their function category.

Resilience Champions across different function categories work collaboratively, especially on cross-cutting pathways, to help ensure efforts to make us more resilient are not 'siloed' within one function category.

10.2 M & E Framework

The diagram in Figure 16 highlights the key elements of the M&E framework to be adopted as part of the adaptation pathways methodology utilised within the CRS.

This framework ensures that the key climate risks identified are regularly reviewed, alongside assessing whether the current adaptation approach being implemented are sufficient to mitigate against the potential impact of future climate risks. If the adaptation approach is currently sufficient, then it should be maintained and monitored on a regular basis. If the approach is not sufficient, then it should be reviewed based on the tipping points and potential future impact of the climate risks.

This monitoring is a continuous process that will be carried out at regular intervals or strategic points in time. The M&E framework for the CRS will be conducted in-line with Ofgem's 5-year price control review period, with reporting updates provided prior to the next price control submission.

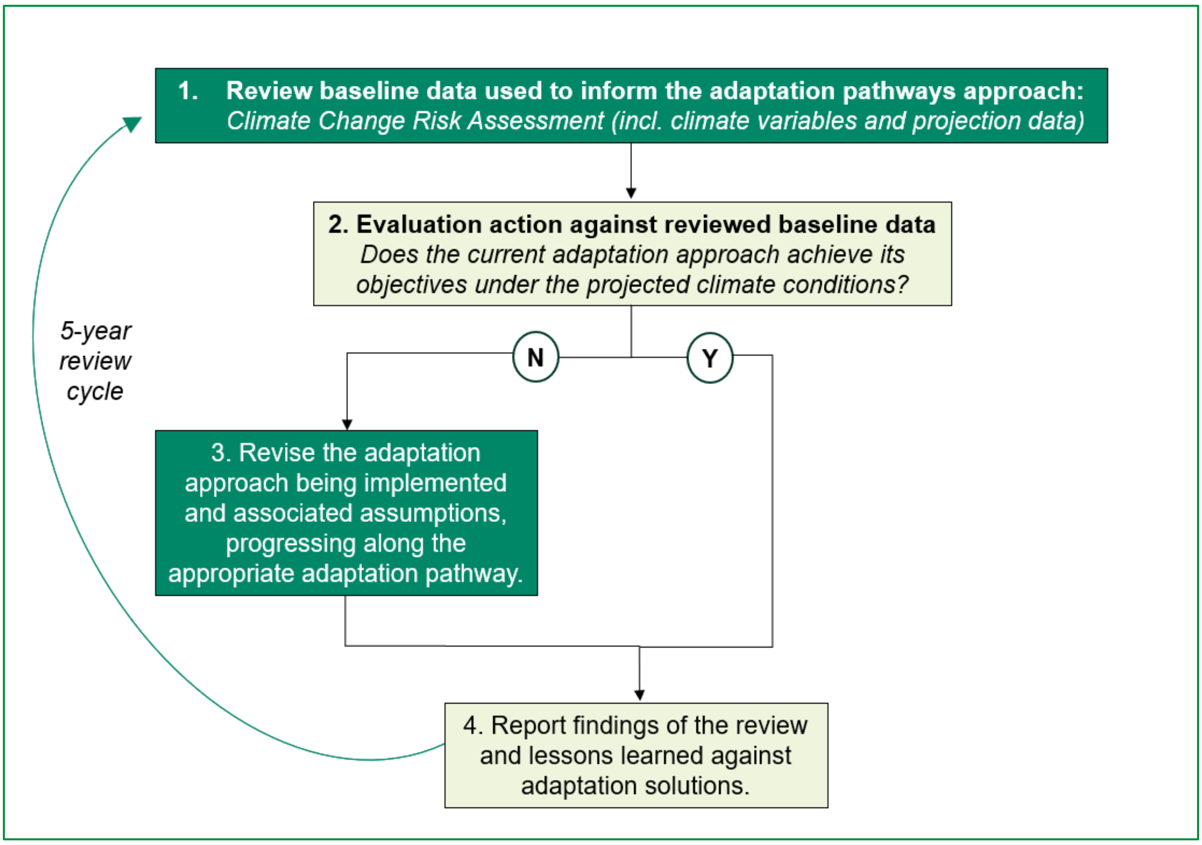


Figure 16: Key monitoring and evaluation steps for SP Energy Networks to maintain climate resilience

10.2.1 Monitor and Review Baseline Data: Climate Risk Assessment and Tipping Point Criteria/Thresholds.

In order to effectively assess whether the current adaptation approach adopted is enough to mitigate against the impacts of climate change, key climate variables and their associated impacts against the network and business functions should be tracked and analysed to help inform associated consequence ratings applied in the risk assessment. This data will also be evaluated against decision criteria and thresholds used to inform the tipping points within the adaptation pathways approach.

Concurrently, the climate change projection data should be periodically reviewed in the light of any new scientific findings, such as updated Met Office UK Climate Projections or environment agencies (SEPA/EA/NRW) flood risk data.

This review will help inform any required changes to likelihood rating applied to the climate risk assessment, alongside the decision thresholds used by the tipping points. Using a Design Threshold/Climate Variable tipping point perspective example, if the projected maximum temperature values are more severe or climate thresholds are to be reached sooner than originally expected, the adaptation solutions pathway will be revisited, moving to the next solution option in the pathway where necessary.

From a response-led tipping point perspective, if seasonal variability is more severe than expected and therefore growing seasons are extended and this has an impact on the number of observed faults or an increase in the cost/time spent on cutting cycles, then the pathway will be revised. This approach will also help inform current uncertainties within the climate model community, an example being the projections for wind and storminess.

Additionally, the review of the baseline data should also incorporate the latest available information and best practice on climate resilience from our associated stakeholders, such as the Energy Network Association (ENA) Adaptation to Climate Change Task Group. This should also include a review of the risk matrix criteria and definitions applied to ensure they are up to date in light of any new information.

1. Evaluate Actions Against Reviewed Baseline Data.

This stage involves identifying whether each implemented action is having the desired results and impacts, including the evaluation of positive and negative, intended, and unintended long-term effects of the adaptation solutions. This will be undertaken as part of a 'lessons learned' analysis, which is necessary to facilitate learning about what is and what is not working in terms of the adaptation solutions. The review of action performance therefore needs to also identify areas of good practice and areas for improvement. Determining what adjustments need to be made is required in order to maximise the potential for positive impact. Examples of questions to ask include:

- Has there been sufficient flexibility in the adaptation approach to allow alternative courses of action to be pursued?
- Have there been any financial benefits from implementing adaptation actions, for example, cost-benefit analysis, fewer working days lost, more efficient operations?

During this evaluation of the actions, consideration should also be given to whether any observed extreme climate events have had undesired impacts on our network or business operations, or have come close to causing undesired impacts, and review whether operational plans were sufficient.

2. Revise if the adaptation approach being implemented is progressing along the appropriate adaptation pathway.

Based on the review of the baseline information data and the evaluation of the actions, the adaptation pathway should be revised to ensure that an appropriate solution is being implemented that effectively mitigates against future impacts.

3. Reporting

In-line with the 5-yearly price control periods, a report will be produced and presented regarding the CRS which will include a summary of:

- Change in baseline data: Climate Risk Assessment and Tipping Points,
- Action implementation status and any issues encountered including lessons learned,
- Recommendations for revisions to any actions and progression along pathways, and;
- Potential new actions for consideration.

10.3 Integration with existing SP Energy Networks Risk Assessment

We currently apply an Enterprise Risk Management Framework, the purpose of which is to assist in the achievement of both short and long terms goals of the company. The process of which is outlined within the document "BUPR-04-011[55]".

It is important to ensure that the key climate risks identified within our CRS are integrated and monitored within this risk management framework. Each month, we are required to produce a Key Risk Register (KRR) which is submitted to the SP Energy Networks Holding Board, Iberdrola and the SP Risk Team.[56] In order to produce the monthly KRR, each SP Energy Networks Licence Area is required to produce an individual KRR and submit it to the Business Assurance for review and consideration.

The individual business unit reports are additionally utilised to populate and update the Asset Risk Register. A draft KRR for the month is tabled at the Executive Performance Meeting for debate, after which it is finalised. It is then submitted to our Holding Board for discussion.

Where possible, Resilience Co-ordinator(s) communicate with the internal Business Assurance Team and representatives of the areas within SP Energy Networks that the risk reporting covers.

[55] SP Energy Networks (2014). Guidelines on Risk Reporting – BPR-04-011. SP Energy Networks.

10.4 Barriers to Implementing Climate Resilience.

We don't foresee any barriers to making a viable case for Climate Resilience in our organisation. Our wider business has already seen the impacts of climate change not only on our own network but around the world. We have already carried out significant work across the network to make the system more resilient to climate change and to mitigate against key risks already. There may be external barriers such as scarce resources for key contractors and equipment when set against the resource intensive RIIO-T3 & RIIO-ED2 investment plans. Further external barriers may be encountered when engaging with stakeholders, such as local planning authorities, to implement some of our Nature Based Solutions.

11. Summary

The UK Climate Change Act 2008 has set the UK target to reduce greenhouse gas emissions by at least 100% by 2050, from a 1990 baseline. The Act also gave the Secretary of State the power to require companies to report on their preparedness for climate change, under the Adaptation Reporting Power.

The Adaptation Reporting Power was first exercised in 2010, when the Secretary of State required a number of companies responsible for infrastructure and other essential services, including distribution and transmission companies and others in the power sector, to report on their preparedness to adapt to impacts of climate change.

Following on from the third Adaptation Reporting Power call, in December 2023 the Secretary of State invited companies which had submitted reports under the first three rounds to submit an update on their levels of preparedness for climate change. The primarily focus of this report is to cover the following:

- The current and future predicted effects of climate change on our organisation
- Our proposals for adapting to climate change.

Our previous 3rd round climate adaption report, published in 2021, highlighted the following actions for SP Energy Networks to mitigate the impact of climate change:

- At a high level, SP Energy Networks will continue to include climate change impacts and concerns in the high-level decisions regarding e.g. new assets, infrastructure, and planning;
- On the ground, SP Energy Networks will continue to implement flood resilience measures as indicated by available flooding data, which will be updated as further data becomes available; and
- Improve storm resilience with investment in our Overhead Line (OHL) network in compliance with ETR132 Specification.
- The introduction of a robust Monitoring and Evaluation framework to ensure that key climate risks are regularly reviewed.

Climate predictions for all climate metrics have continued to increase, this is shown in the data presented within sections 3 & 4 of this report. The data shows that the UK climate continues to change with projections that winters will be 4.5% warmer whilst being 30% wetter. Summers will continue to up to 6% hotter and 60% drier. The number of windstorm events are also predicted to increase which may lead to more disruption across the UK electricity network.

Storm Arwen, which occurred in November 2021, caused electricity disruption to almost 1 million customers. While 83% of disrupted UK customers had their power restored within 24 hours, a small but significant proportion experienced disruption for up to 11 days. This storm highlighted the impact that extreme weather events can have on UK electricity customers. As such the Electricity Sector was forced to reconsider its investment strategy and to start prioritising network resilience in the face of global climate change.

This 4th round report demonstrates how we have fulfilled and built upon the above actions as follows:

- As a business, we have been focusing on managing key climate risks ever since the publication of our first adaptation report in 2011. Improving resilience to flooding has been provided as a detailed example, with the recommendations from ETR 138 incorporated into our 'Substation Flood Resilience Policy' SUB-01-018, which applies to substations at all voltages within SP Energy Networks for both existing and new substation installations (Section 5). These policies form the basis for our flood mitigation work elements of both our RIIO-T3 and RIIO-ED2 business plans (Section 5).
- We have developed Climate Resilience Strategies for both our Transmission[57] and Distribution[58] business to support our RIIO business plans. These reports form the basis for our Transmission and

[57] https://www.spenergynetworks.co.uk/userfiles/file/Climate-Resilience-Strategy-RIIO-T3-Business-plan-SP-Energy-Networks.pdf
[58] https://www.spenergynetworks.co.uk/userfiles/file/Annex_4A.7-Climate_Resilience_Strategy.pdf

Distribution businesses to become more resilient to Climate Change thus supporting the UKs journey towards Net Zero.

- Our Storm Arwen reopener award, in the wake of the 2022 review, will allow us to invest a further £22m into making our OHL network more resilient to storms, plus speed up supply restoration when power cuts do occur.
- We have continued to update our risk assessment to identify key climate risks to our network and develop adaption pathways for key climate risks (Sections 6, 7 and 8). This process has identified the actions we must take, based on the most up to date climate projections, to ensure our network remains resilient to climate change impacts. This includes specific short to medium term actions for the highest risks identified: summer drought; fluvial and pluvial flooding; sea level and storm surge; and coastal flooding (Section 9).
- We have continued to develop our Monitoring and Evaluation framework to ensure that key climate risks are regularly reviewed, alongside assessing whether the current adaption approach that is being implemented is sufficient to mitigate against the potential impact of future climate risks.
- We will continue to work in collaboration with the ENA & Ofgem to progress the development of a Climate Resilience Metric (CRM) that will help to monitor company performance and progress in the industries journey to be resilient to climate change.
- Our work with our partners on the CReDo project will continue to help us better understand the interdependencies between energy, water and telecoms networks which will strengthen the UK utility sectors ability to withstand climate change.

SP Energy Networks

Climate Adaptation Report, Round 4

December 2024

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