SSEN DISTRIBUTION RIIO-ED2

# CLIMATE RESILIENCE STRATEGY

RIIO-ED2 Business Plan Annex 7.3

Scottish & Southern Electricity Networks

# Contents

# 1. ABOUT THIS STRATEGY

## 1.1 SCOPE & PURPOSE

This strategy outlines how we will adapt to the impacts of climate change, make use of adaptation pathways, and identify the steps we need to take in ED2 to improve our resilience to the effects and risks of climate change.

Electricity networks, as all civil infrastructure, will be affected by the physical impacts, as well as the societal and financial impacts, of climate change. Recent extreme climate events illustrate the extent of this potential exposure, demonstrated in the 2021 Texas Power Crisis that saw widespread power outages, extensive property damages and loss of life. In the UK, an increase in the frequency of heatwaves is already felt, affecting electricity networks' assets such as substations, transformers and switchgears. At the same time an increase in the use of air conditioning in offices and homes and a national transition to greener energy is leading to higher demand for electricity, adding strain to electricity networks across the country.

We operate in  different regions of the UK, from densely urban regions on the southern coast of England to scarcely populated farmland areas in the Scottish Highlands. Our commitment to our 3.8 million consumers for reliable energy delivery in the coming decades is challenged by the adverse risks of climate change, such as an increase in flooding, extreme temperatures, drought and wildfires. We are committed to understand these challenges, find sustainable solutions to tackle them and adapt to a changing climate.

The path to Climate Resilience is through a detailed, complex, multi-faceted risk management plan with many factors, variables and uncertainties. Climate change risks are studied, assessed, and prioritised, and the climatic difference between our southern regions and northern regions are investigated. Interdependencies of our operation with other stakeholders (such as telecoms, electricity transmission, water utilities, etc.) are understood to highlight the key vulnerabilities for both us and our stakeholders. We summarise our climate risks now and in 2050 to identify the impacts of climate change and how this differs between our operations in the south and the north.

We present an Adaptation Plan based on this assessment and knowledge of our networks, and an implementation plan to embed, monitor and communicate progress on our adaptation to climate change. Our plans are primarily targeting improvements in our current processes, which recognise the great work carried out to date on our existing defined processes, thus avoiding unnecessary costs to our customers.

Best practice examples of innovative projects relating to adaptation and mitigation, already on their way or envisaged for the future, are also presented. Climate adaptation is not a one-off process, but a gradual shift in corporate culture to the way infrastructure is designed, maintained and operated in the 21st century. This strategy 2021 Climate Resilience plan is a crucial step on the pathway to green, decentralized, carbon free, and reliable electricity.

## 1.2 HOW THIS STRATEGY ALIGNS TO OUR CORE BUSINESS VALUES & SUSTAINABILITY AMBITIONS

Our Climate Resilience strategy reflects our values in an integrated manner. With safety at its basis, mitigation is mainly about ensuring electricity distribution hazards are prevented from impacting our ability to serve our customers. It is then ensuring and enhancing service and efficiency, in an approach that sees long term sustainability as the guiding light. Investments in resilience often have a positive benefit-cost ratio—that is, every pound spent on mitigating risk before a damaging event occurs, returns multiple pounds of value over the life of the investment. We see climate change mitigation, adaptation and disaster prevention as reflecting best our commitment to our consumers.

## 1.3 HOW THIS STRATEGY ALIGNS TO OFGEM'S REQUIREMENTS

We have developed our Climate Resilience Strategy in line with the requirements set out in Ofgem's **RIIO-ED2 Business Plan Guidance (April 2021)**[1]

| Section | Requirement | Our Response |
|---|---|---|
| **3.28** | **Business plans must include a dedicated climate resilience strategy** | This document serves as our dedicated climate resilience strategy, outlining how we plan to adapt to the impacts of climate change on our network over the long-term (see *'Our Adaptation Priorities'*). This strategy also includes the use of adaptation pathways (see *'Adaptation Pathways – An evidence based and agile risk management approach'*) to inform the programme of work that we will carry out over the price control period to ensure our network remains resilient to the effects of climate change. |
| **3.29** | **The DNO must consider a range of plausible climate change projections and the impacts for its region** | We have used *'Energy Industry Specific Risk Assessment on Climate Change Impacts – Work Package 3 Report'* published by the Met Office for the basis of future climate projections and risks, which is described in *'The Climate Change Challenge'*. The projections used for temperature rises and/or relevant risks are based on the Met Office's UKCP18 (RCP 8.5) models, which aligns to the assumptions outlined in the Paris Agreement, the National Infrastructure Commission, the UK Government and the Committee on Climate Change. |
| **3.30** | **The DNO should coordinate with other parties, local authorities, and/or other DNOs to develop its strategy** | We have considered the impacts of climate change in relation to cascading and escalating failures of infrastructure across independent sectors as part of developing this strategy within our interdependency analysis (see *'Indirect Impacts of Climate Change and Interdependencies'*). We have also outlined how we have, and will, coordinate with other parties, local authorities and other DNOs to further manage these climate risks and enhance this strategy (see *'Collaborate & Learn'*). |
| **3.31** | **The DNO must identify the steps that it expects to take over the course of RIIO-ED2** | We have identified the steps that we expect to take over the course of RIIO-ED2 for managing our climate resilience and improving our approach to climate resilience in *'Plan and Act'* and *'Manage, Monitor, & Improve'*, respectively.<br><br>We demonstrate how we have considered the impacts on our networks in *'The Impact of Climate Change on our Business'* and how we propose to mitigate these impacts in *'Our Adaptation Priorities'*. We have outlined how we will contribute to cross-sector work on climate resilience (e.g. a climate resilience working group) in *'Collaborate & Learn'*. We also outline our initial plan for demonstrating progress against our strategy in *'Understand and Communicate'*. |

[1] https://www.ofgem.gov.uk/system/files/docs/2021/04/riio-ed2_business_plan_guidance_-_april_2021.pdf

# 2. THE CLIMATE CHANGE CHALLENGE

**Our Regions and their Climate**

We operate in two distinct geographic regions, Northern Scotland and Central Southern England. These two regions differ in many of their geographic characteristics, current climates conditions, and their projected changes.

**Climate Change in Northern Scotland**

In general, Scotland is expected to experience warmer, wetter, winters, with more intense rainfall events; and hotter, drier summers, with greater extremes. Average temperatures will increase across all seasons, intense rainfall events will increase, sea levels will rise gradually which will make storms harsher on coasts, but there will be reduced frost and snowfall.

In the 2012 Great Britain and Ireland floods, landslides blocked both main East Coast and West Coast rail lines, and localised flooding occurred in the Trossachs, South Argyll and parts of Dumfries and Galloway. Roads, including the A83 in the Scottish Highlands were closed due to landslip. Gale-force winds and unusually high tides caused damage across areas of eastern and northern Scotland. 3 October 2020 was the wettest day on record for the UK since 1891; average rainfall across the entire UK was 31.7mm, which was enough to exceed the capacity of Loch Ness, the largest lake in the UK.

In terms of cold spells, Braemar in Scotland got down to -23.0°C on the morning of 11 February 2021, the UK's lowest temperature since 1995 and the lowest in February since 1955.


**Climate Change in Central Southern England**

Central Southern England, including the cities of Reading, Basingstoke, Guildford, Southampton and all or part of Oxfordshire, Berkshire, Surrey, Hampshire and Wiltshire, is expected to get warmer, with summer heatwaves becoming more frequent and intense. Summer rain is expected to decrease while winter rainfall will increase. Intensity of rainy days, in all seasons, is set to increase.

The maximum daily temperature currently exceeds 28°C two to five times per year in Central Southern England. Southern England registered the highest peak summer temperatures of the UK in the heatwaves of 2018 and 2019. Southampton registered 35.6°C on 28 June 2018 (a UK June record), and 32.3°C at 23 July 2019.

The winter season of 2013-2014, the wettest on record since 1766, saw unprecedented rainfall in Surrey of 275% compared to the average in winter, and caused wide destruction to transport infrastructure and buildings.

## 2.1 CLIMATE PROJECTIONS

The information used is taken from the UK Climate Projects 2018 (UKCP18)[2], provided by the MET Office and approved by the government. UKCP18 is the latest generation of climate change information for the UK, and its projects are based on a methodology designed by the UK MET Office. UKCP18 reflects scientists' best understanding of how the climate system operates, how it might change in the future and allows a measure of the uncertainty in future climate projections to be included. The Met Office released the UK Climate Projections 2018 on November 2018.

| 2030-2040 | Northern Scotland | South England |
|---|---|---|
| **Hottest Summer Day** | +2.1°C | +2.5°C |
| **Hottest Winter Day** | +0.7°C | +0.6°C |
| **Annual Days above 25°C** | +1 day | +5 days |
| **Rainy Days per Month (Summer)** | No Change | -1 days |
| **Rainy Days per Month (Winter)** | No Change | No Change |
| **Wettest Summer Day** | +3mm | +5mm |
| **Wettest Winter Day** | No Change | +6mm |

Table 1- UKCP Climate Change Projections for 2040-2050

UKCP18 has included, for the first time, convection-permitting model, on par with operational weather forecast models, that provides local-level projections. This model allows us to examine the risk of extreme weather events in SSEN Distribution regions for the coming decades, and make distinct recommendations for the two main regions, Northern Scotland and Central Southern England. We refer to the 'non-technical summary' in **UKCP Convection-permitting model projections: Science report (September 2019)** on how this resolution was achieved. Our assessment below highlights the national difference that climate change brings between our Northern Scotland and Central Southern England areas. We will commit to build on this and develop a more granular understanding of the different effects of climate change across our 7 regions, as shown in Appendix A: SSEN Regions and Geography.

### *Scenarios and Assumptions*

We have considered two scenarios for assessing the risks of climate change; a 2020 baseline and a 2050 scenario based on climate projections from UKCP18 RCP 8.5 assumptions, as outlined in *'Energy Industry Specific Risk Assessment on Climate Change Impacts – Work Package 3 Report'* published by the Met Office.

UKCP18 Representative Concentration Pathway (RCP) 8.5 is a greenhouse gas concentration trajectory adopted by the International Panel on Climate Change in 2014. RCP 8.5 is described as a worst case scenario, it is based on a model where mean global temperature increase by 2.0°C by 2050 and 4.3°C by 2081 - 2100. RCP 8.5 was seen, in the context of the Paris Agreement (2015), as business-as-usual, suggesting that it is a likely outcome if society does not make concerted efforts to cut greenhouse gas emissions.

[2] https://www.metoffice.gov.uk/research/approach/collaboration/ukcp/index

We will commit to investigate additional scenarios and timeframes, which could include an assessment of our risks to climate change at the end of the century and to different climate model scenarios.

### *Temperature*

Average summer temperature in both regions is expected to rise to above 2°C by 2050 and 4°C by 2070-2080. Average winter temperature is expected to rise by 0.5 – 1°C to 2°C by 2070-2080. An increase in average summer temperatures will lead to an increase in seasonal (summer) electricity demand due to increased use of air conditioning, impacting the capacity and resilience of our network during these times.

The frequency of extreme heat days (days where the daily maximum temperature is greater than 28°C) is expected to increase to approximately 16 days per year in Central Southern England, up from less than four days per year currently however, this change is less severe in Northern Scotland. The likelihood of experiencing a summer as hot as that in 2018 will be two to five times more likely by 2050 than it is now, increasing to an annual likelihood of 50%, due to climate change.

Increasing temperatures will potentially affect our overhead line conductors, underground cable systems, transformers and switchgears.

### *Rainfall and Drought*

The intensity and frequency of rain events are expected to increase in both Northern Scotland and Central Southern England, but more so in the south, however, the overall volume of rain is expected to decline in summer and increase in winter. Scotland will see a summer decline of rainfall of 10% by 2050 and 15-20% by 2080, and winter increase of 5-10% by 2050, to 10-12% by 2080. Southern England could see a summer decline of 20% by 2050 and 30-40% by 2080, with winter increase of 10% by 2050 and 15-20% by 2080. An increase in the intensity of rainfall will lead to a greater likelihood of pluvial and fluvial flooding, which could have a significant impact on our substations.

Summer decline of rainfall would also lead to prolonged periods of summer droughts, which are expected to rise in duration and frequency. Frequency of extreme drought events across Scotland, for example, could increase from an average of one every 20 years to one every three years[3].

[3] https://www.nature.scot/risk-extreme-droughts-likely-increase-scotland

### *Storms and Lightning*

Climate change impact on storms intensity or frequency is inconclusive. Some, but not all, evidence supports an increase in gales, storms and tidal surges (combined with sea level rise). Figure 2 – UKCP18 Model for mean change in significant wave height by 2100 shows the projected rise in wave height, however where it is grey, such as in the east coast of central Scotland, the uncertainty is higher than 75%.

Lightning strikes are the second highest cause of customer interruptions and minutes lost on our network in Southern England, and it is the fifth highest cause in Northern Scotland. Lightning affects overhead lines and transformers, however, current research suggests that there will be no significant change in the frequency of lightning strikes due to climate change.

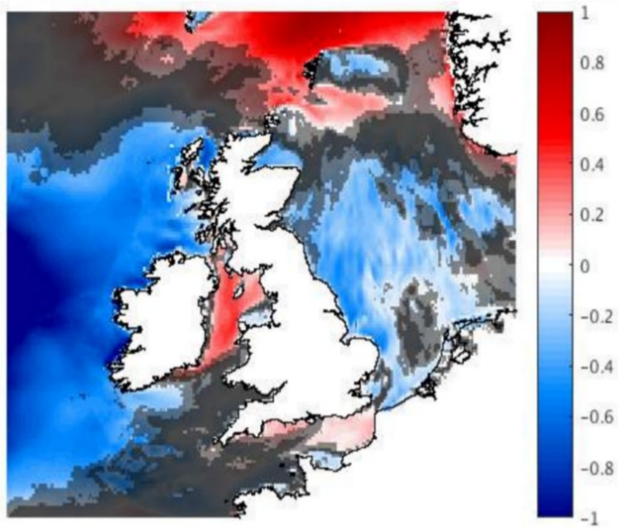


Figure 2 – UKCP18 Model for mean change in significant

### *Wildfires*

Wildfire is a natural and essential part of some ecosystems. Recently, there has been a global surge of large wildfires and prolonged fire seasons, associated with a complex mix of climate change, changing land management practices and human behaviour. UK climate projections indicate that climatic factors conducive to elevated wildfire conditions will increase. The UK Climate Change Risk Assessment and National Adaptation Programme identified wildfire as a climate change risk. According to recent research from the University of Reading, the number of days with conditions hot and dry enough for serious wildfires in the south of England will climb from 20 a year today to 111 by the 2080s. West Scotland is projected to have 16 days of suitable conditions, up from three today.

### *Sea Level Change*

Sea levels are set to rise with climate change, where the current modelling from UKCP18 shows that this increase is greatest along the Channel Coast compared to the Scottish Coast. By the end of the century the sea is projected to rise by one metre on the southern coast, and only half a metre along the Scottish coast. Rising sea levels will increase the likelihood of flooding of our substations near the coastline.

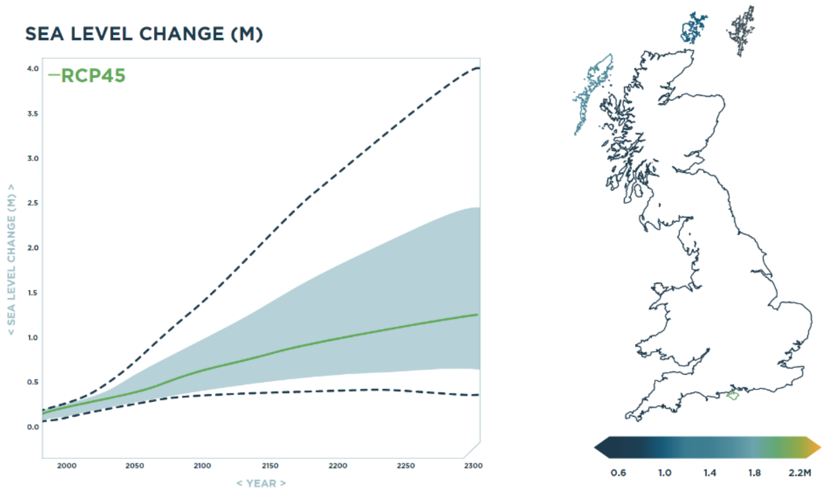


Figure 3 – UKCP18 projection for sea level change (m)

### *Wind*

The evidence in relation to an increase in hazards due to strong wind events, is developing, and we are continuing to look at the impact this will have on our network and what that will mean for the design of our new assets and the resilience of our existing network. The Committee for Climate Change most recent publication - Independent Assessment of UK Climate Risk[4] warns us that the UK has already fallen behind in preparing for, and adapting to, climate change; of particular note to energy companies the report identifies risks to people and the economy from climate-related failure of the power system as one of eight key risk areas the UK needs to address in the next two years. The report argues that costs related to addressing the impacts of climate change could triple by the 2080s if more isn't invested now into mitigation and adaptation.

# 3. PRINCIPLES OF EFFECTIVE CLIMATE RESILIENCE

The Paris Agreement was introduced in 2016 to limit global temperature rise and it established a global adaptation goal of "enhancing adaptive capacity, strengthening resilience and reducing vulnerability to climate change…". Our approach for effectively managing climate resilience and adaptation has been developed based on the principals provided within *ISO 14090:2019 Adaptation to climate change – Principles, requirements and guidelines*, which is broken down into the following areas:

1. **Assessing climate change impacts** - includes opportunities and shall be assessed comprehensively, covering cross-cutting (systemic) issues including impacts directly and indirectly on the organisation
2. **Adaptation Planning** - assemble an adaptation plan from varied sources of knowledge, information and data, in the context of existing policies, strategies, planning and decision-making processes
3. **Implementation** - Developing an implementation plan is critical to the delivery of the adaptation plan and the preparation of a monitoring and evaluation plan
4. **Monitoring and Evaluation** - used to assess, inform and review the adaptation plan so that satisfactory progress is confirmed and indications of unsatisfactory progress are highlighted early enough
5. **Reporting and Communication** - communicating our climate change adaptation to interested parties external to our organisation

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

## 3.1 THE FOUNDATIONS OF OUR APPROACH TO ASSESSING CLIMATE RISK

**Climate Risk Assessment Methodology**

Risk is a product of impact and likelihood, and we have assessed the risks of climate change against the 15 risks to electricity networks defined by DEFRA[5] and the ENA[6] using this industry standard approach. These risks were assessed for each of the national areas to take account of the localised effects of climate change and understand the relative priorities across these areas.

| | | Impact | | | | |
|---|---|---|---|---|---|---|
| | | Limited | Minor | Moderate | Significant | Extreme |
| Likelihood | Almost Certain | 5 / moderate | 10 / major | 15 / major | 20 / severe | 25 / severe |
| | Likely | 4 / moderate | 8 / moderate | 12 / major | 16 / major | 20 / severe |
| | Possible | 3 / minor | 6 / moderate | 9 / moderate | 12 / major | 15 / major |
| | Unlikely | 2 / minor | 4 / moderate | 6 / moderate | 8 / moderate | 10 / major |
| | Very Unlikely | 1 / minor | 2 / minor | 3 / minor | 4 / moderate | 5 / moderate |

We've taken a top-down system wide view of our assessment of climate risks, to identify the critical points of our network and specific vulnerabilities to climate change, we will commit to undertaking a bottom-up site based assessment of our climate risks and resilience across our 7 regions.

### *Assessing Impact*

The impact of climate risks has been assessed based on the scale and duration of a failure and/or cost/ability to maintain service. The table below defines the individual levels of impact.

| Rating | Definition |
|---|---|
| **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. |

[5] https://www.gov.uk/government/organisations/department-for-environment-food-rural-affairs/about
[6] https://www.energynetworks.org/

| Rating | Definition |
|---|---|
| **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. |

### *Assessing Likelihood*

The likelihood of climate risks has been assessed based on the historic evidence of experiencing and/or managing the events in the past. The table below defines the individual levels of Likelihood.

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

### *Assessing Climate Risks in Northern Scotland and Central-Southern England*

The region specific climate risks across Northern Scotland and Central Southern England are assessed individually. The Impact and Likelihood for each climate risk (described in Direct Impacts of Climate Change below) is determined by the type of risk (e.g. if the impact is localised or not), the relative population density of the two regions, and the current and change in likelihood of climate related hazards that are expected to be different (e.g. max temperature or sea-level rise will be greater in the South).

The assessment results of each risk in the Northern-Scotland and Central-Southern England are provided in Appendix C: *'Breakdown of SSEN's Climate Change Risk Assessment Results'*.

### *Confidence Levels*

The climate data used in this strategy is based mainly on the UKCP18 climate models. All climate models exhibit systematic differences between model results and observations, and in order to take account of this, every risk is presented with accompanying Confidence Level, to make sure stakeholders preform a bias-correction approach when assessing actions to mitigate risks. See **UKCP18 Guidance: How to Bias-Correct**.

Assessments of the relative confidence in climate projections should ideally be based on a comprehensive set of observational tests that would allow us to quantify model errors in simulating a wide variety of climate statistics. This should include simulations of the mean climate and variability and of particular climate processes. The collection of measures that quantify how well a model performs in an ensemble of tests of this kind are referred to as 'climate metrics'. To have the ability to constrain future climate projections, they would ideally have strong connections with one or several aspects of climate change:

- Climate sensitivity.
- Large-scale patterns of climate change (inter-hemispheric symmetry, polar amplification, vertical patterns of temperature change, land-sea contrasts).
- Regional patterns or transient aspects of climate change.

We have used a scale of Low, Medium and High confidence to reflect assurance in the different projections, where:

- **Low** - reflect high uncertainty in projections, this relates to the intangible climatic phenomenon as, for example, lightning**.** Or risks associated with physical conditions beyond the scope of UKCP18, as ground movements due to draughts.
- **Medium -** May relate to either intermediate confidence in the extent of a certain climatic event, as the frequency and extent of heatwaves, or, to the effects of a certain physical condition in relation to hazard, as for example, raising heat on maintenance of electric gear.
- **High -** Reflects high confidence in the climatic projection, and/or in the hazard imposed by that climatic event. This include, for example, the risks imposed by different flooding situations.

## 3.2 ADAPTATION PATHWAYS – AN EVIDENCE BASED AND AGILE RISK MANAGEMENT APPROACH

An appropriate decision making approach is needed to address the uncertainties in climate change projections. The Adaptation Pathways approach has been successfully applied for infrastructure, utilities, and broader cross-sector adaptation planning. This approach allows us to plan, prioritise and stagger investment in our adaptation options based on thresholds and trigger points to assess the decision required and incorporate flexibility into our adaptation plans.

Our adaptive pathways approach gives us time before decisions need to be made, which allows us to continually develop our Climate Resilience strategy, reduces uncertainty from making decisions today, provides flexibility to local circumstances, and enables us to learn along the way.

We will commit to develop our Adaptation Pathways as part of our analysis of thresholds (the point at which adaptation action will be required) and will be used to prioritise our actions as part of our climate change adaptation plan.

### *Threshold Analysis*

Thresholds analysis requires us to identify the critical thresholds that will cause our distribution system to suffer an intolerable shift in performance, as defined by ISO 14090. The aim will be to identify and determine the current proximity to these thresholds, and develop an adaptation plan that will reduce the likelihood of crossing these thresholds.

Thresholds can be very difficult to define, however, it is not necessary to quantify thresholds precisely to be able to apply thresholds analysis. For our Climate Resilience Strategy we have defined our thresholds against our risk categories (described earlier in our Climate Risk Assessment Methodology).

| Risk Threshold | Adaptation Response |
|---|---|
| **Severe** | Capital investment in system, network and/or sites to reduce vulnerability or impact of critical failure due to climate risk |
| **Major** | Accelerate enhancement, replacement of sites and/or invest in system or network resilience if risk approaches ‘Severe’ threshold |
| **Moderate** | Monitor risks periodically (minimum annually) and accelerate maintenance, replacement or enhancement of sites if risk approaches and is expected to exceed ‘Major’ threshold |
| **Minor** | Monitor risks periodically (minimum 5 year cycle) and maintain or replace assets in line with maintenance/replacement schedule |

We will identify the thresholds that we need to be aware of and investigate the proximity to thresholds of potential concern. Our analysis of thresholds and their equivalent measures will include, but not be limited to:

- **Temperature** – average (mean) summer temperatures and frequency (instances per annum) of heatwaves.
- **Precipitation** – summer drought and extreme winter rainfall (intensity and duration).
- **Vegetation** – growth rate.
- **Storms** – annual frequency and intensity of storm events.
- **Sea level** – change in annual average and peak levels.

We will review and update our adaptation plan and associated thresholds annually.

## Value based choices - Factoring climate risks into decision making

The decisions that are made as part of adaptation planning needs an integrated, sustainable and value based approach to appreciate the benefit of any risk mitigation or adaptation action. Adaptation actions can provide a broad spectrum of benefit and value to our customers, society, environment, workforce and financial expenditure. A multi-criteria decision making approach with a 6 Capitals valuation framework provides a consistent and transparent method to make holistic value based choices. 6 Capitals are measures of value that are affected by activities, risks and decisions of an organisation, which include:

1. **Social Capital** – encompasses the safety, service, economy of our stakeholders, including our customers, communities, regulators and suppliers
2. **Natural Capital** – includes the value and impact on biodiversity, carbon emissions, embodied carbon, noise pollution, and air quality
3. **Human Capital** – represents the safety, wellbeing, skills and know-how of our personnel
4. **Intellectual Capital** – accounts for the intangibles associated with our reputation, intellectual property and organisational systems/processes
5. **Manufactured Capital** – encompasses the physical assets, land, technology or equipment that we own and/or manage
6. **Financial Capital** – the traditional yardstick of organisational performance, represented by cash and expenditure

We will commit to investigate the use of making future climate adaptation decisions based on a multi-criteria 6 capitals approach.

# 4. THE IMPACT OF CLIMATE CHANGE ON OUR BUSINESS

## 4.1 DIRECT IMPACTS OF CLIMATE CHANGE

15 potential direct impacts of climate change to our assets and operation were identified as part of our involvement in the ENA (Energy Networks Association) Climate Change Adaptation reporting (2021[7]), which have been listed below. These 15 risks describe how temperature, drought, flooding, lightning, and wildfires can directly impact our overhead lines, underground cable systems, substations, network earthing systems, switchgears, and overall demand on our system.

- AR1 Overhead line conductors affected by temperature rise, reducing rating and ground clearance.
- AR2 Overhead line structures affected by summer drought and consequent ground movement.
- AR3 Overhead lines affected by interference from vegetation due to prolonged growing season.
- AR4 Underground cable systems affected by increase in ground temperature, reducing ratings.
- AR5 Underground cable systems affected by summer drought and consequent ground movement, leading to mechanical damage.
- AR6 Substation and network earthing systems adversely affected by summer drought conditions, reducing the effectiveness of the earthing systems.
- AR7 Transformers affected by temperature rise, reducing rating.
- AR8 Transformers affected by urban heat islands and coincident air conditioning demand leading to overloading in summer months.
- AR9 Switchgear affected by temperature rise, reducing rating.
- AR10 Substations affected by river flooding due to increased winter rainfall.
- AR11 Substations affected by pluvial (flash) flooding due to increased rain storms in summer and winter.
- AR12 Substations affected by sea flooding due to increased sea levels and/or tidal surges.
- AR13 Substations affected by water flood wave from dam burst.
- AR14 Overhead lines and transformers affected by increasing lightning activity.

[7] Energy Networks Association: Adaptation to Climate Change Task Group, Gas & Electricity Transmission and Distribution Network Companies, 3rd Round Climate Change Adaptation Report, March 2021

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

## 4.2 INDIRECT IMPACTS OF CLIMATE CHANGE AND INTERDEPENDENCIES

Our and other stakeholder systems depend upon interconnections and services of each other and the impact resulting from the service failure of one can have cascading impacts on the other systems. Understanding interdependencies are therefore critical to fully understanding the resilience of our operation due to climate change and how we could potentially impact the resilience of others.

We have identified a number of key areas of interdependencies and provide an overview of where the dependencies exists below. We will commit to further investigate and analyse our interdependencies to develop a better understanding of the impacts of climate change on our business.


Figure 4 – Interdependency map of SSEN Distribution's key stakeholders

### *Customers*


Customers are a broad area of stakeholder groups representing bill payers, vulnerable customers, high-priority customers (such as hospitals, prisons etc), industrial customers, and other commercial customers who depend on us. Clearly customers are dependent on us to distribute electricity but customers can also have an impact on our ability to supply due to climate change, for example warmer summers could put additional demand on peak supply.

### *Water Utilities*


Our operational boundaries overlap with a large number of Water and Wastewater utility companies (e.g. Scottish Water, Southern Water, Wessex Water, Thames Water, South East Water, and Cholderton & District Water etc). Water companies are dependent on us to operate their treatment works and pump stations and rely on back-up power generation as a temporary resilience measure in the instance of any power outages. The impact of significant loss of power could lead to loss of clean water supply to the public and environmental pollution if they are not able to operate their assets. This impact is exaggerated if this happens during a heatwave, drought or flooding event.

### *Telecoms*


Our dependencies are highly vulnerable to the failure of telecom infrastructure (provided by British Telecoms, Openreach for example). With the greater reliance on smart networks in the future, both to monitor and manage the performance of assets through telemetry and SCADA, failure in the ability to do this for a prolonged period can have a significant impact on our service. This type of failure was evidenced in 2015 when a number of infrastructure services (such as water and highways) lost connection to their assets when a BT telephone exchange was flooded in York. Telecoms are also dependent on SSEN to operate sites and assets and rely on back-up power generation as a temporary resilience measure in the instance of any power outages.

### *Highways*


Highway assets impacted by flooding could impede our ability to access sites and assets, especially those that require personnel to operate them. This impact is exemplified where an SSEN site is flooded and access to the site to manage the event is also impeded, reducing our ability to effectively respond and recover services. Highway authorities' (such as Highways England, Transport Scotland and Local Authorities) assets that require electricity (e.g. street lighting, traffic signals, pump stations) are dependent on us to provide safe and reliable roads to the public.

### *Railways*

Network Rail, Train Operating Companies and Freight Operating Companies rely on electricity to run and manage the railway. Loss of power could lead to significant impacts on the railways, leading to severe delays/cancellations and the ability to operate other key operational assets such as pump stations, especially where this is not completely mitigated by back-up power generators/storage.


An example of this impact was seen in 2019 when two of National Grid's power generators had major issues leading to power cuts across large areas of England and Wales and the delay and cancellation of trains.

### *Environment*

The Environment Agency, Scottish Environment Protection Agency, and local authorities manage many of the major flood and coastal defences in England and Scotland. Failure of these defences that SSEN depend on could lead to the flooding of assets and a loss of service for our customers. The same agencies also depend on us to provide power to some of their flood defences (such as pump stations) and so there is a very strong inter-dependency here. In addition to physical harm to electric equipment, flooding in and in the surrounding of our facilities could mean adverse impact on habitats and wildlife.


### *Electricity Generation and Transmission*

We depend on the generation and transmission of electricity to be able to deliver electricity to customers. Climate change that impacts electricity generation companies (e.g. EDF, Centrica, E.ON, RWE npower, Scottish Power and Southern & Scottish Energy etc) and Transmission companies (e.g. SHE Transmission, National Grid) will have an impact on us, which needs to be considered.


### *Gas Supply and Distribution*

Gas supply and distribution companies (e.g. National Grid Gas, SGN, Wales & West Utilities etc) have a common function to us; to supply energy to customers, and an impact on one to supply gas or electricity has an impact on the demand required of the other. This was evidenced in the power outage in Texas in 2021, where the failure of the gas supply system due to severe winter storms resulted in unprecedented demand on the electricity network and led to rotating outages to prevent electricity demand from overwhelming the grid.

## 4.3 OTHER IMPACTS

The above sections have identified a range of risks which impact on the network assets (premises and processes) that form the key to the UK electricity network infrastructure. There are a range of other potential impacts that have been considered and are described below.

### *Markets*

It is likely that climate change itself will bring about a greater take-up of air conditioning load with increased penetration into the domestic sector. However, against this increased demand there are opposing drivers through new building standards and other Government initiatives on thermal efficiency together with EU Energy Using Products Directives. Of greater impact are climate change mitigation actions in support of the low carbon economy, which are projected to have an increase and a decrease pull on electricity consumption. A decrease is projected through implementing energy efficiency measures, such as thermal efficiency and electric appliances standards. In the same timeframe, a raise is projected with more and more services becoming electric, namely transport (private cars and public transportation) and heating, with government aim to decrease the use of natural gas. The overall trend in the UK is a slight decrease of electricity consumption since 2005, as transport currently uses about double the amount of energy being produced for electricity, electricity demand is projected to raise three-fold by 2050, double the rate it has been raising since 1970.

### *Finance*

The sector is financed through RIIO price control mechanisms administered by Ofgem. It will be necessary for the industry to agree with Ofgem and the Department for Business, Energy and Industrial Strategy (BEIS) the approach, funding and timescales for adaptation.

### *Logistics*

The industry is not reliant upon day by day supply of raw material in the same manner, for example as a coal fired power station. However, it does require supply of new equipment to install new connections for Customers, to build new network extensions or enhance existing infrastructure to meet new demand and to replace old or faulted equipment. These products are increasingly drawn from a European and global marketplace sometimes involving significant shipping distances, and prone to supply chain delays. Network operators already consider stock holding and replenishment time risks as part of resilience planning and have been subject to review by the former DTI and BERR. Only the largest items cannot be air-freighted if the need arose and it would require simultaneous disruption of road / sea and air transport to have major effect.

### *People and Society*

In the event of significant levels of absence due to health/heat impacts, the industry would re-deploy staff from longer term work, onto fault fixing, and then curtail planned work. The plans that were prepared for pandemic flu, executed during the lockdowns of the COVID-19 pandemic (2020-2021), serve as a model for this approach. In addition staff may be affected by disruption to normal travel arrangements caused by extreme events such as flooding or heat waves and there will be dependencies with the transport sector including the Highways Agency and rail and air transport companies.

### *Vulnerable Customers*

Vulnerable customers such as the elderly or low-income are specifically prone to suffer more in climatic events that disrupts ordinary life, as loss of electricity due to floods or heatwaves that exacerbate heat stress. We aim to understand specific needs of communities it is operating in to relieve such pressures.

### *Staff Safety and Wellbeing*

Extreme climatic events, as floods, storms and heatwaves, can pose challenges to our technical crews responding to network failures. This can be manifested in access difficulties or inadequate working conditions.

## 4.4 OPPORTUNITIES

Climate change projections, by and large, pose a risk for our operation and assets by its physical impacts and other systematic ripple effects. Nevertheless, some advantages can be realised as part of a mitigation plan. In terms of better climatic conditions that will ease our operation, Scotland is positioned to gain in several aspects. Warmer weather in the Scottish highlands may lead to:

- Less snow leading to less ice accretion on overhead lines that can compromise structural integrity.
- Easier access to carry out maintenance, as well as helicopter access to carry out fault location.
- Less loading of the system because of less severe cold spells.
- Reduced ageing due to mechanical tension in overhead lines due to a smaller temperature gradient.

Another possible opportunity is the rise in technical knowledge that will be acquired while preparing for extreme climates, which includes:

- Methods of trees and electric equipment to co-exist and provide protection.
- Technical studies such as the EU research COST 727 that investigated impacts of ice loading.
- Incentives to develop more robust equipment and protection that will protect SSEN operation from risks wider than climatic ones.

## 4.5 SUMMARY OF RISK ASSESSMENT RESULTS

The following are climate risks identified for power grids in the UK, this mainly stem from:

- Changes in precipitation cycles (e.g. concentrated rain events, droughts).
- Warmer temperature (e.g. heatwaves, raise in average temperature, raise in day-night gradient).
- Floods (e.g. river, flash flood, sea flood).
- Other (e.g. Lightning, wildfires).

These are looked on per asset class basis, with assessment for risk in a future (2050) climate, prior to proposed adaptation measures, and their projected trend. It should be noted that some risks represent an extreme event, while others are a gradual decline in service that could lead to increased maintenance in the future, if not addressed.

### *Key Climate Change Risks between now and 2050*

Of the climate risks surveyed and assessed, we see a general trend of raising risk towards the 2050s. The most severe risk is flooding, which is already in its highest level at current climate, and this risk cannot go any higher in the matrix, although its severity and probability are highly likely to increase. Some long term risks, as high temperatures causing reduced ratings and require more maintenance are expected to fall as new technologies are implemented.

| Climate Risks | 2020 | 2050 | Trend |
|---|---|---|---|
| AR1 Overhead line conductors affected by temperature rise, reducing rating and ground clearance | 9 | 12 | ▲ |
| AR2 Overhead line structures affected by summer drought and consequent ground movement | 2 | 4 | ▲ |
| AR3 Overhead lines affected by interference from vegetation due to prolonged growing season | 9 | 9 | ▶ |
| AR4 Underground cable systems affected by increase in ground temperature, reducing ratings | 10 | 10 | ▶ |
| AR5 Underground cable systems affected by summer drought and consequent ground movement, leading to mechanical damage | 1 | 2 | ▲ |
| AR6 Substation and network earthing systems adversely affected by summer drought conditions, reducing the effectiveness of the earthing systems | 6 | 6 | ▶ |
| AR7 Transformers affected by temperature rise, reducing rating | 6 | 4 | ▼ |
| AR8 Transformers affected by urban heat islands and coincident air conditioning demand leading to overloading in summer months | 4 | 4 | ▶ |
| AR9 Switchgear affected by temperature rise, reducing rating | 8 | 6 | ▼ |
| AR10 Substations affected by river flooding due to increased winter rainfall | 20 | 20 | ▶ |
| AR11 Substations affected by pluvial (flash) flooding due to increased rain storms in summer and winter | 20 | 20 | ▶ |
| AR12 Substations affected by sea flooding due to increased sea levels and/or tidal surges | 20 | 20 | ▶ |
| AR13 Substations affected by water flood wave from dam burst | 5 | 5 | ▶ |
| AR14 Overhead lines and transformers affected by increasing lightning activity | 6 | 6 | ▶ |
| AR15 Overhead lines and underground cables affected by extreme heat and fire smoke damage | 9 | 12 | ▲ |

### *Key Climate Risks in 2050 in Northern Scotland and Central Southern England*

While climate trends are in general similar in both our regions of operation, Central Southern England is set to be more affected by heat related risks, with the Scottish region not expected to reach levels of heat that will become a hazard.

| Climate Risks in 2050 | Northern Scotland | Central Southern England |
|---|---|---|
| AR1 Overhead line conductors affected by temperature rise, reducing rating and ground clearance | 6 | 12 |
| AR2 Overhead line structures affected by summer drought and consequent ground movement | 2 | 4 |
| AR3 Overhead lines affected by interference from vegetation due to prolonged growing season | 4 | 9 |
| AR4 Underground cable systems affected by increase in ground temperature, reducing ratings | 8 | 10 |
| AR5 Underground cable systems affected by summer drought and consequent ground movement, leading to mechanical damage | 2 | 2 |
| AR6 Substation and network earthing systems adversely affected by summer drought conditions, reducing the effectiveness of the earthing systems | 6 | 6 |
| AR7 Transformers affected by temperature rise, reducing rating | 4 | 4 |
| AR8 Transformers affected by urban heat islands and coincident air conditioning demand leading to overloading in summer months | 4 | 4 |
| AR9 Switchgear affected by temperature rise, reducing rating | 6 | 6 |
| AR10 Substations affected by river flooding due to increased winter rainfall | 20 | 20 |
| AR11 Substations affected by pluvial (flash) flooding due to increased rain storms in summer and winter | 20 | 20 |
| AR12 Substations affected by sea flooding due to increased sea levels and/or tidal surges | 20 | 20 |
| AR13 Substations affected by water flood wave from dam burst | 5 | 5 |
| AR14 Overhead lines and transformers affected by increasing lightning activity | 6 | 6 |
| AR15 Overhead lines and underground cables affected by extreme heat and fire smoke damage | 9 | 12 |

# 5. OUR ADAPTATION PRIORITIES

## 5.1 PLAN AND ACT

The Action Plan outlined below proposes an initial mitigation strategy to each of the 15 potential direct impacts of climate change, as presented in the previous section ('Direct Impacts of Climate Change'). The adaptation pathways work programme has driven key actions to be delivered as a result. As we continue to drive our sustainability ambitions, the action plan is primarily targeting improvements in our current processes recognising the great work carried out to date, existing defined processes, and avoiding unnecessary costs to our customers. Indirect impacts are addressed previously in section 4.2.

**Adaptation Action Plan to our Direct Climate Risks**

| Adaptation Actions | 2050 Risk | Mitigated Risk | Change |
|---|---|---|---|
| **AR1 Overhead line conductors affected by temperature rise, reducing rating and ground clearance**<br>1. Review and update design standards for Overhead Lines to specify the upsizing of capacity to meet future load demands and projected higher temperatures | 12 | 9 | ▼ |
| **AR2 Overhead line structures affected by summer drought and consequent ground movement**<br>1. Summer droughts can cause ground shrinkage which can lead to de-stabilisation of the foundations of single structures and towers. A technical review is to be carried out to ascertain the real risk of this occurring and any mitigation required | 4 | 4 | ► |
| **AR3 Overhead lines affected by interference from vegetation due to prolonged growing season**<br>1. Tree cutting cycle frequency increased from 4 to 3 years to maintain current risk score in SEPD as climate is more favourable. Frequency remaining at 4 years for SHEPD<br>2. Use LIDAR to aid in the management of trees is being explored allowing a better understanding of circuit resilience to amassed. This will allow risk based tree management to be employed<br>3. Use LIDAR to aid in the management of trees is being explored allowing a better understanding of circuit resilience to amassed. This will allow risk based tree management to be employed<br>4. A project to determine if a tree resilient overhead line has been instigated. The idea is to ensure that the line can remain live but also safe with a tree having fallen onto it. This will use covered conductor and 'Smart' technology to detect when a tree has fallen on the line | 9 | 6 | ▼ |

| Adaptation Actions | 2050 Risk | Mitigated Risk | Change |
|---|---|---|---|
| **AR4 Underground cable systems affected by increase in ground temperature, reducing ratings**<br>1. Investigate and determine the effects of increase in ground temperature on underground cable systems<br>2. Verify the thermal models of the cables currently being used for distribution cables<br>3. Consider the effects of the changes to cyclic loading to LV levels | 10 | 8 | ▼ |
| **AR5 Underground cable systems affected by summer drought and consequent ground movement, leading to mechanical damage**<br>1. Review and update (if required) design standard for the use of ducted systems and joints at high voltage in urban environments to mitigate the impacts of the drying out of soils | 2 | 2 | ► |
| **AR6 Substation and network earthing systems adversely affected by summer drought conditions, reducing the effectiveness of the earthing systems**<br>1. Investigate a risk based approach to inspect and monitor changes in conditions of network earthing systems | 6 | 6 | ► |
| **AR7 Transformers affected by temperature rise, reducing rating**<br>1. Where transformers have radiators, investigate the need for increasing the size of the radiators or the use of water cooling to comply with excess heat and reduce temperature<br>2. Explore installation of temperature monitors for monitoring temperature conditions in distribution substations and current primary substation where applicable | 4 | 2 | ▼ |
| **AR8 Transformers affected by urban heat islands and coincident air conditioning demand leading to overloading in summer months**<br>1. Where transformers have radiators, investigate the need for increasing the size of the radiators or the use of water cooling to comply with excess heat and reduce temperature<br>2. Explore installation of temperature monitors for monitoring temperature conditions in distribution substations and current primary substation where applicable | 4 | 2 | ▼ |
| **AR9 Switchgear affected by temperature rise, reducing rating**<br>1. New design standard will have the provision for suitable environmental conditions (e.g. increased ventilation, air-con and dehumidification) that will function in line with climate changes<br>2. Consider the provision for ventilation/air-conditioning in current substations | 6 | 2 | ▼ |

| Adaptation Actions | 2050 Risk | Mitigated Risk | Change |
|---|---|---|---|
| **AR10 Substations affected by river flooding due to increased winter rainfall**<br>1. Assess risk and resilience of critical Substations affected by river flooding and where required develop a local flood mitigation plan<br>2. Build and invest in flood mitigation measures for critical Substations affected by river flooding (e.g. raising individual sites above the flood level or the installation of temporary barriers). Continue to develop substations in guidance with ETR138 which applies to Grid / Primary sites<br>3. Consider the use of flooding maps developed by EA & SEPA | 20 | 20 | ► |
| **AR11 Substations affected by pluvial (flash) flooding due to increased rain storms in summer and winter**<br>1. Assess risk and resilience of critical Substations affected by river flooding and where required develop a local flood mitigation plan<br>2. Build and invest in flood mitigation measures for critical Substations affected by river flooding (e.g. raising individual sites above the flood level or the installation of temporary barriers). Continue to develop substations in guidance with ETR138 which applies to Grid / Primary sites<br>3. Consider the use of flooding maps developed by EA & SEPA | 20 | 20 | ► |
| **AR12 Substations affected by sea flooding due to increased sea levels and/or tidal surges**<br>1. Assess risk and resilience of critical Substations affected by river flooding and where required develop a local flood mitigation plan<br>2. Build and invest in flood mitigation measures for critical Substations affected by river flooding (e.g. raising individual sites above the flood level or the installation of temporary barriers). Continue to develop substations in guidance with ETR138 which applies to Grid / Primary sites<br>3. Consider the use of flooding maps developed by EA & SEPA | 20 | 20 | ► |
| **AR13 Substations affected by water flood wave from dam burst**<br>1. Continue to monitor the current position regarding dam burst and take action where necessary | 5 | 5 | ► |
| **AR14 Overhead lines and transformers affected by increasing lightning activity**<br>1. Continue with the current strategy to use class 2 surge arresters | 6 | 6 | ► |
| **AR15 Overhead lines and underground cables affected by extreme heat and fire smoke damage**<br>1. Although the Home Office has responsibility for wildfire risk and focuses on extinguishing fires with other management responsibilities split between government departments, we will explore wildfire areas and look towards prevention methods | 9 | 12 | ▲ |

## 5.2 UNDERSTAND AND COMMUNICATE

We are committed to ensuring climate change risks are managed from the identification and implementation of adaptation measures to the ongoing review and monitoring through our internal risk processes. Policy documents, codes of practice and progress reports will be updated to consider the impact of climate change on the business. It is clear that an understanding of climate change risk will play an important part in business planning. Consideration is given to the actions that should be taken to either reduce the likelihood of occurrence or reduce the impact in a timely manner.

We have earlier highlighted and described a number of stakeholders in our assessment of interdependencies and other risks. It is important that we communicate the progress of our actions and collaborate on the issues of climate change adaptation with our stakeholders. The main groups of stakeholders who we will keep updated with progress on our climate resilience strategy are:

| Stakeholder Group | What we will communicate | How we will communicate | How often |
|---|---|---|---|
| **Customers and public** | Action taken to improve our resilience to climate change | Website and newsletter | Annually |
| **Investors** | Current risks, future risks and adaptation plan | Annual TCFD reports | Annually |
| **Other DNOs** | Approach and sharing best practice of climate resilience | Climate Resilience Working Group | Quarterly |
| **Utility and Infrastructure providers** | Interdependent risks and sharing best practice of climate resilience | Local climate resilience forums and direct engagement | Quarterly |
| **Regulators** | Progress of improvement plan, processes and governance | Annual progress report | Annually |

## Reporting progress against the Strategy

We will submit an Annual Progress Report to Ofgem, highlighting the progress we have made against our Adaptation Plan and Improvement Implementation Plan. We will include an update of our climate risk assessment, including a more local view of our risks and resilience, the meetings and forums that we have completed and how we are incorporating climate change into our decision making.

Our climate adaptation actions will also be fed into the our wider Sustainability Strategy, informing the environmental/social aspects of SSEN's operations.

## Taskforce for Climate related Financial Disclosures

In 2015, G20 Finance Ministers and Central Bank Governors asked the Financial Stability Board (FSB) to review how the financial sector can take account of climate-related issues[8]. The FSB established the Task Force on Climate-related Financial Disclosures (TCFD) to develop recommendations for more effective climate-related disclosures. Its aims are to:

- Promote more informed investment, credit, and insurance underwriting decisions and
- Enable stakeholders to understand better the concentrations of carbon-related assets in the financial sector and the financial system's exposures to climate-related risks.

In November 2017, we committed to meeting the TCFD recommendations in full by March 2021.

The Carbon Disclosure Project (CDP) is a not-for-profit charity that runs the global disclosure system. We have responded to CDP's[9] requests for disclosure to the Climate Change Programme since 2004 and have reported data on the carbon intensity of our electricity generation from 2006 in our Annual Report. We have provided detailed Green House Gas (GHG) emission disclosures in our Annual Report since 2013, in line with the requirements introduced through the Companies Act 2006. Since then we have significantly improved our climate-related disclosures, in particular over the past few years as the expectations and demands of our stakeholders in relation to climate-related disclosure have evolved.

SSE has focused on identifying and quantifying its significant climate-related risks and opportunities, enhancing governance and management of climate-related issues and developing its own scenario analysis to assess the impact of climate-related risks and opportunities on its businesses. SSE's climate-related disclosures in its Annual Report pages 82 to 85 are structured by the four themes of the TCFD recommendations to provide clear, accessible and transparent information for our stakeholders. SSE responds annually to CDP's Climate Change Programme, which is aligned to the TCFD recommendations and was awarded an 'A-' for its response to the 2019 CDP Climate Change Programme.

[8] https://www.fsb.org/work-of-the-fsb/financial-innovation-and-structural-change/climate-related-risks/
[9] https://www.cdp.net/en

## 5.3 MANAGE, MONITOR & IMPROVE

Electricity Transmission and Distribution Companies are Licenced and Regulated by Ofgem under the powers of The Electricity Act 1989 as amended by the Utilities Act 2000. The Act spans a wide range of topics, but of particular relevance are aspects that encompass Price Control, duties on Companies to comply with legislation and on Ofgem to ensure that Companies are adequately funded to discharge their duties.

Another key piece of legislation is the Electricity, Safety and Continuity Regulations 2002 (as amended) ("the "ESQCRs"). This places duties on network companies to ensure their equipment is sufficient for the purposes for and circumstances in which it is used and constructed, used and maintained so as to prevent danger, or interruption of supply so far as is reasonably practicable. Companies are thus already under an ongoing obligation to ensure the adequacy of their equipment against current "normal" conditions.

Ofgem currently undertakes 5-yearly Price Control Reviews of Transmission and Distribution Companies, looking in depth at their investment plans, performance and cost efficiency. This includes benchmarking network operators against each other. This process is supplemented by an annual Regulatory Reporting process designed to track progress against the 5 year plans. In exceptional circumstances, such as arising from costs imposed by newly introduced legislation within any Price Control period, Ofgem may agree a "re-opener" against those related areas of cost.

The industry approach to identification, risk assessment and development of mitigation plans for major substations at risk of flooding, provides an illustration of the way in which joint work on adaptation could be pursued. A working group was established under the ENA, with membership from each of the member electricity network companies together with EA, SEPA, Met Office, DECC and Ofgem. A report was prepared by the Group and submitted to the Energy Minister. That Report has formed the basis of common standard submissions to Ofgem in the recent Price Control review and will be regarded by DECC as the industry standard, if necessary by referencing it, similarly to other ENA documents, in the Guidance to the ESQCRs.

Monitoring by Ofgem of progress on adaptation can then be facilitated via a common approach through the existing Price Control and the annual Regulatory Reporting processes which is the Companies' preferred approach. This process will continue to use latest information as it becomes available.

## Climate resilience improvement and implementation plan

In the table below we outline an initial plan for demonstrating progress against our Climate Resilience Strategy and improve our approach to climate change adaptation going forward. These are initial actions that we want to carry out from now, we shall not wait until ED2 to start on with this critical work, we want to build on our progress, which we will then continue forward into ED2 and beyond.

| Area | Action | Timescale |
|---|---|---|
| **Assessing Climate Change Risks** | Investigate the effects of climate change across our 7 different regions | 2021 - 2022 |
| | Identify the critical thresholds that will cause our distribution systems to suffer an intolerable shift in performance, and undertake threshold analysis | 2021 - 2022 |
| | Establish clear responsibilities, roles and leadership within SSEN to own and drive our climate resilience strategy | 2021 - 2022 |
| | Further investigate and analyse our interdependencies to develop a better understanding of the impacts of climate change on our business | 2021 - 2022 |
| | Investigate additional scenarios and timeframes, which could include an assessment of our risks to climate change at the end of the century and to different climate model scenarios | 2022 |
| | Investigate additional direct climate impacts and risks, such as coastal erosion | 2022 |
| **Adaptation Planning** | Establish clear responsibilities, roles and leadership within SSEN to own and drive our climate resilience strategy | 2021 - 2022 |
| | Collaborate with stakeholders to develop an Adaptation plan for the indirect and interdependent climate risks assessed | 2022 onwards |
| | Develop an Adaptation plan for other risks associated with climate change | 2022 |
| | Further Develop Adaptation Pathways to prioritise our climate change adaptation actions | 2022 |
| | Investigate the use of making future climate adaptation decisions based upon a multi-criteria 6 capitals approach | 2022 |
| | Embed climate risk and resilience into business as usual strategic, tactical, and operational decision making and investment governance | 2022 onwards |
| **Reporting and Communication** | Actively participate in the Climate Change Resilience Group established in early 2021 with other ENA members | 2021 onwards |
| | Support BEIS' Climate Services for a Net Zero Resilient World programme | 2021 - 2022 |
| | Identify the climate risks associated with our low-income and vulnerable customers/communities, and work together to manage these risks | 2023 |
| | Continue to contribute to TCFD reporting with updated climate risk and resilience assessment results | Annually |
| **Monitoring and Evaluation** | Update policy documents, codes of practice and progress reports to consider the impact of climate change | 2021 - 2022 |
| | Review and update our climate risk and resilience assessment | Annually |
| | Review and update our adaptation plan | Annually |
| | Monitor proximity and likelihood of exceeding defined climate thresholds | Annually |

## 5.4 COLLABORATE & LEARN

The activities and groups that we describe below outline how we will work across the electricity sector and coordinate with other parties and sectors on further developing climate resilience best practice.

### Climate Change Resilience Group

We shall continue to collaborate with other ENA Members to form the Climate Change Resilience Group (CCRG) on the issue of industry-wide adaption to climate change and in doing so will develop a learning system. The purpose of this working group is to provide a forum for ENA Members and wider industry to consider and develop the mitigation and management processes impacting the long-term physical resilience of their networks and give full consideration to the additional risk associated with climate change. The CCRG will regularly update Electricity Networks and Futures Group (ENFG) and Resilience and Emergency Co-ordination Group (RECG), and attendees of ENFG will report relevant information back to CCRG. The terms of Reference of this group was agreed by all parties and meetings commenced in early 2021.

### Climate Equity and working with local communities

Climate change is expected, in general, to disproportionally affect low-income communities, those who are least responsible for climate change emissions. Yet these same communities could disproportionately benefit from strategies to address and adapt to climate change. We value our customers and we seek to contribute to the communities we supply electricity to. Therefore, we will seek to make investments that will contribute to the social value of the regions we serve. In addition, we will seek to develop our climate resilience policy so that it will enhance intergenerational (across generations) and intragenerational (within a generation) prosperity.

We will also seek to identify our low-income and vulnerable customers, and the climate risks associated with their communities. We will work together with communities to co-operate on climate change adaptation, in light of our obligation to address human wellbeing, and in our view that equity is not always in tension with strong climate action or collective action.

## Climate Services for a Net Zero resilient World

BEIS will be initiating a project for Climate Services. The overall aim of this provision is to ensure that BEIS policies and priorities are informed by up-to-date policy-relevant evidence & scientific advice, where this is required to inform decisions.

This includes:

- Its domestic net zero efforts.
- Infrastructure, housing and engagement with local authorities on local climate action plans.
- Bilateral and multilateral interactions on climate change & trade.
- Activities within international fora such as the Intergovernmental Panel on Climate Change and the United Nations Framework Convention on Climate Change
- Cross-government international climate strategies.

The project covers the provision of new evidence, original research & analysis, knowledge translation & communication, in support of BEIS domestic and international work, covering the following areas of science:

- Interactions between the energy system and the atmosphere.
- Global decarbonisation and ambition.
- Climate impacts, globally, regionally, and at a country-level.
- Co-benefits of climate action.
- Improving the accessibility of UK climate data (knowledge translation only).
- Physical climate change (knowledge translation only).

In light of this, we are committed to support this project on understanding the risks for energy network infrastructure, assets and processes, including any cascading and systemic risks. This includes quantification of risks for the timescales of 5, 10, 20 and 30 years from now.

## Stakeholders and interdependent systems

We will seek to work with our stakeholders and interdependent systems to understand cascading and systematic risks that may be afflicted on our system or inflict on other critical infrastructure from failures in our system. This will also look at existing and new no- or low-regrets options to enhance climate resilience of our infrastructure, assets and processes against current and future climate risks.

## Our track record for adapting to climate change

### *Smart grids*

Transforming the electricity system is a crucial component of climate resilience. A smarter grid could contribute to both climate change mitigation and adaptation by increasing low-carbon electricity production and enhancing system reliability and resilience. The term "smart grid" is used to represent a variety of interlinked social and technological changes to electricity systems, particularly modernising networks that link electricity producers and consumers through advanced information and communication technologies. This system provides redundancy to the network and increases overall resilience, in particular to adverse climate conditions. We are committed to invest in these solutions by conducting larger and larger experiments with interconnected systems. The following are two recent examples:

### *Project ERIC*[10]


The £1.2million UK Government funded Energy Resources for Integrated Communities project (ERIC), demonstrates how distributed generation (solar PV) and smart battery storage in a community can be managed to reduce average peak grid load and increase self-consumption of local PV generated electricity across the Rose Hill estate in Oxford, benefiting both local people and the environment. ERIC has installed smart battery storage packs and electricity-generating photovoltaic panels on more than 80 homes, plus a community centre and a school. An electric car club is also part of the research and demonstration project.

### *Project Leo*[11]

Project Local Energy Oxfordshire (LEO), an innovative multi-million-pound smart grid trial that is working to understand how communities can play an active role in the journey towards climate resilience. By creating opportunities for communities to trade the energy they generate, use, and store at a local level, Project LEO will empower people, companies, and local areas to build an energy system that works for people and planet (See further details in our DSO Strategy Annex 11.1).

[10] http://lowcarbonoxford.org/case_studies/project-eric-energy-resources-integrated-communities/
[11] https://project-leo.co.uk/

# Appendix A SSEN REGIONS AND GEOGRAPHY

## Central Southern England

### *Wessex*

Largest SSEN Region, densely populated coastal region and the large New Forest National Park. With large urban centres as Weymouth, Bournemouth, Poole and Southampton, as well as Salisbury. Compromising parts of Hampshire and Dorset Counties, serving population of roughly 1.7 million people. Wessex Region geography is low land in general, with hilly parts and many rivers and streams flowing to the English Channel, as: River Avon, River Stour, River Test.

### *South East*

In the north, the region is part of the outer ring of the London urban area, with Farnham and Basingstoke at its north-eastern point. The middle part is mostly rural with many small villages and towns, bordered by the South Downs hills, to the densely populated coastal strip, with urban centres as Chichester and Portsmouth. the Isle of Wight is considered a part of this region. The region's population is roughly 1.5 million people.

### *Thames Valley*

The most populated SSEN region, in the east it is part of the London Boroughs of Ealing and Hillingdon, including London Heathrow Airport, and the urban centres of Slough, Egham, Bracknell, Maidenhead, Woking and Reading. West of Reading, the area is mostly rural, with the exception of the town of Newbury. The River Thames is flowing from the north to Reading and then Eastward to London. River Kennet is flowing from the west, joining the Thames at Reading. The area topography is mostly flat close to the Thames, and hilly further from it. Population comprises roughly 2.4 million people.

### *Ridgeway*

Ridgeway comprises the counties of Oxfordshire (including the City of Oxford), Gloucestershire, and Wiltshire. In its borders to urban centres Swindon and Chippenham. Most of the area is rural, population is roughly 1.5 million people.

## Northern Scotland

### *South Caledonia*

A vast region of the southern Highlands of Scotland, comprised of the regions of Argyll & Bute and Tayside & Central. To the south it borders (but does not include) the Central Belt with the major urban centres, to the east it borders (and does not include) the county of Fife. To the north it borders the Grampian Mountains and Mounth hills and Cairngorms mountains, it then incorporates more areas to the north all the way to the Great Glen. The north western border is at Glen Affric. To the west it incorporates the region of argyll with it islands and Lochaber region along the west coast. The region area comprises about 60,000 square kilometres and is mostly rural. It has many rivers which mostly flow in a west-east direction including: Forth, Earn, Tay and the Dee. The regions' south side has towns as Perth, Dundee, with many coastal towns in between. In the north part a few towns, mainly relying on tourism exist, including Oban, Fort William and Inverness. The northern and western part is mountainous and mostly uninhabited.

### *North Caledonia*

The smallest of Scotland's SSEN regions, it comprise 20,000sq kilometres of the lowlands around the town of Aberdeen, with sparse agricultural population spread evenly. This includes the historic counties of Aberdeen, Banff, Moray and Nairn. It has many fishing towns as Peterhead and Fraserburgh that has, apart from fishing industries, food processing and textiles plants.

### *Highlands & Islands*

The most northern region is the vast mountainous region north of the Great Glen and includes the islands of Orkney and the western isles: Lewis and Harris and north and south Usk. The population is mainly coastal, with little hamlets in the mountains. The landscape is very rugged, and the exposed northerly position give rise to exceptionally low winter sunshine levels.

# Appendix B DESCRIPTION OF CLIMATE HAZARDS AND IMPACTS ON SSEN

The direct climate risks assessed in our strategy are described in more detail below.

**AR1 Temperature Overhead line conductors affected by temperature rise.**

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

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

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

**AR2 Temperature Overhead line structures affected by Summer drought and consequent ground movement**

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

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

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

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

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

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

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

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

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

### AR7 Temperature Transformers affected by temperature rise

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

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

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

### AR9 Temperature Switchgear affected by temperature rise

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

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

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

Refer to AR12.

### AR11 Precipitation Substations affected by pluvial (flash) flooding due to increased rain storms in Summer and Winter

Refer to AR12.

### AR12 Precipitation Substations affected by sea flooding due to increased rain storms and/or tidal surges

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

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

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

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

### AR 14 Overhead lines and transformers affected by increasing lightning activity

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

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

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

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

# Appendix C BREAKDOWN OF SSEN'S CLIMATE CHANGE RISK ASSESSMENT RESULTS

Climate change risks have been assessed, taking into account ENA Risk Matrix and SSEN Draft ARP. Likelihood and Impact are assessed for current and future climate based on UKCP18.

**AR1 Overhead line conductors affected by temperature rise, reducing rating and ground clearance**

Overhead line conductors are affected by temperature rise and growing gradient between peak temperatures, this is expected all over the UK, but more so in the southern region than in Scotland, by a factor of 3-4. The likelihood rating for the southern region has thus, increased, putting this risk in 'Major' category. Possibly this risk will go up due to increased loadings (move towards more electric than gas) hence reduced clearances.

| AR1 | Likelihood 2020 | Impact 2020 | 2020 | Likelihood 2050 | Impact 2050 | 2050 | Confidence Level | Trend |
|---|---|---|---|---|---|---|---|---|
| **Northern Scotland** | 2 | 2 | **4** | 3 | 2 | **6** | **MEDIUM** | ▲ |
| **Central-South England** | 3 | 3 | **9** | 4 | 3 | **12** | | |
| **SSEN Overall** | 3 | 3 | **9** | 4 | 3 | **12** | | |

**AR2 Overhead line structures affected by summer drought and consequent ground movement**

Dry soils condition are considered low risks in current and future climates, across all regions. Likelihood is raising across the UK, and more so in the future climate projected for southern England. This puts the risk there at 'Moderate' up from 'Minor'. Confidence level in this is low, as this risk specifically was not projected in the UKCP18.

| AR2 | Likelihood 2020 | Impact 2020 | 2020 | Likelihood 2050 | Impact 2050 | 2050 | Confidence Level | Trend |
|---|---|---|---|---|---|---|---|---|
| **Northern Scotland** | 1 | 2 | **2** | 1 | 2 | **2** | **LOW** | ▲ |
| **Central-South England** | 1 | 2 | **2** | 2 | 2 | **4** | | |
| **SSEN Overall** | 1 | 2 | **2** | 2 | 2 | **4** | | |

**AR3 Overhead lines affected by interference from vegetation due to prolonged growing season**

SEPD have already noticed that the growing season has increased in the south, and this has led to increase in tree-cutting in recent years. Prolonged growing season due to growing heat and increased seasonal rainfall will become more likely in south England, although the increase in tree-cutting frequency maintains a 'Possible' Likelihood score.

| AR3 | Likelihood 2020 | Impact 2020 | 2020 | Likelihood 2050 | Impact 2050 | 2050 | Confidence Level | Trend |
|---|---|---|---|---|---|---|---|---|
| North Scotland | 2 | 2 | **4** | 2 | 2 | **4** | MEDIUM | ► |
| Central-South England | 3 | 3 | **9** | 3 | 3 | **9** | | |
| SSEN Overall | 3 | 3 | **9** | 3 | 3 | **9** | | |

**AR4 Underground cable systems affected by increase in ground temperature, reducing ratings**

Prolonged growing season in southern England is expected to increase due to more intense rain events, coupled with hotter weather. While the impact of climate change on ground conditions are uncertain, it need to be tested if the projected rise in temperature will affect cable laid in an urban environment, where the soil conditions remain reasonably constant. The greater use of ducted systems at high voltage restrict cable ratings and so the effect of drying out of soils is less important.

Higher ground temperature are projected on all SSEN's regions, this is a minor risk that is 'Almost Certain' also in future climate. This makes the future risk in the southern region 'Major'.

| AR4 | Likelihood 2020 | Impact 2020 | 2020 | Likelihood 2050 | Impact 2050 | 2050 | Confidence Level | Trend |
|---|---|---|---|---|---|---|---|---|
| Northern Scotland | 4 | 2 | **8** | 4 | 2 | **8** | HIGH | ► |
| Central-South England | 5 | 2 | **10** | 5 | 2 | **10** | | |
| SSEN Overall | 5 | 2 | **10** | 5 | 2 | **10** | | |

**AR5 Underground cable systems affected by summer drought and consequent ground movement leading to mechanical damage**

Increased failures from ground movement, following extreme rain and dependent on soil types, is already felt across regions. Ground movement due to summer drought is considered a low risk that will reduce in severity towards 2050. No increase in cable failings related to ground conditions/movements have been reported on SSEN in the past.

| AR5 | Likelihood 2020 | Impact 2020 | 2020 | Likelihood 2050 | Impact 2050 | 2050 | Confidence Level | Trend |
|---|---|---|---|---|---|---|---|---|
| **Northern Scotland** | 1 | 1 | **1** | 2 | 1 | **2** | **MEDIUM** | ▲ |
| **Central-South England** | 1 | 1 | **1** | 2 | 1 | **2** | | |
| **SSEN Overall** | 1 | 1 | **1** | 2 | 1 | **2** | | |

**AR6 Sub-station and network earthing systems adversely affected by summer drought conditions reducing the effectiveness of earthing systems**

Changes that makes the natural variations of ground conditions becoming greater, reducing effectiveness of earthing system, compromising system integrity and creating public safety issues. No increase in likelihood is projected, nor impact. This remains 'Moderate' risk in future climates.

| AR6 | Likelihood 2020 | Impact 2020 | 2020 | Likelihood 2050 | Impact 2050 | 2050 | Confidence Level | Trend |
|---|---|---|---|---|---|---|---|---|
| **North Scotland** | 3 | 2 | **6** | 3 | 2 | **6** | **MEDIUM** | ► |
| **Central-South England** | 3 | 2 | **6** | 3 | 2 | **6** | | |
| **SSEN Overall** | 3 | 2 | **6** | 3 | 2 | **6** | | |

**AR7 Transformers affected by temperature rise, reducing rating**

Transformers to be affected by temperature rise and a rise in day-night temperature gradient. This can affect old transformers equipment, reduce rating and increase maintenance costs. Impacts of this are more long term stress, as this is not likely to cause a sudden system failure. With modernisation of transformers, this risk is projected to decrease in likelihood and remain 'Moderate'.

| AR7 | Likelihood 2020 | Impact 2020 | 2020 | Likelihood 2050 | Impact 2050 | 2050 | Confidence Level | Trend |
|---|---|---|---|---|---|---|---|---|
| **North Scotland** | 2 | 2 | **4** | 2 | 2 | **4** | **MEDIUM** | ▼ |
| **Central-South England** | 3 | 2 | **6** | 2 | 2 | **4** | | |
| **SSEN Overall** | 3 | 2 | **6** | 2 | 2 | **4** | | |

**AR8 Transformers affected by urban heat islands and co-incident air conditioning demand leading to overloading in summer months**

Overheating due to urban heat island occur only in the hotter and urbane South England region, and is highly more likely in Ealing and Hillingdon Boroughs of London. Overloading in summer months is already noticed throughout SSEN operations. This risk should be assessed to increase in likelihood and impact categories. This remains 'moderate' risk in future climate.

| AR8 | Likelihood 2020 | Impact 2020 | 2020 | Likelihood 2050 | Impact 2050 | 2050 | Confidence Level | Trend |
|---|---|---|---|---|---|---|---|---|
| **North Scotland** | 1 | 2 | **2** | 2 | 2 | **4** | HIGH | ► |
| **Central-South England** | 2 | 2 | **4** | 2 | 2 | **4** | | |
| **SSEN Overall** | 2 | 2 | **4** | 2 | 2 | **4** | | |

**AR9 Switchgear affected by temperature rise, reducing rating**

Switchgear affected by higher temperature may stay a moderate risk in 2050 climate for the southern region, and insignificant in Scotland. New equipment is less prone to this hazard due to suitable measures as increased ventilation, dehumidifiers, etc. This is why likelihood is reduced in future climate with a high confidence level.

| AR9 | Likelihood 2020 | Impact 2020 | 2020 | Likelihood 2050 | Impact 2050 | 2050 | Confidence Level | Trend |
|---|---|---|---|---|---|---|---|---|
| **North Scotland** | 4 | 2 | **8** | 3 | 2 | **6** | HIGH | ▼ |
| **Central-South England** | 4 | 2 | **8** | 3 | 2 | **6** | | |
| **SSEN Overall** | 4 | 2 | **8** | 3 | 2 | **6** | | |

**AR10 Sub-stations affected by river flooding due to increased winter rainfall**

River flooding in the Thames Valley, due to projected increased intense rainfall events is considered 'Almost Certain' and 'Extreme'- leading to the highest risk. Impact is exacerbated in densely populated areas due to larger impermeable surfaces and more population concentrated in flood-prone areas. Following the flooding of the Thames in 2014 a strategy has been produced to assess the potential flood level depth at strategic secondary distribution substations using the Environment Agency Flood level Data. Mitigation strategy is being developed and will employ a number of techniques from raising the site to above the flood level to installation of temporary barriers.

| AR10 | Likelihood 2020 | Impact 2020 | 2020 | Likelihood 2050 | Impact 2050 | 2050 | Confidence Level | Trend |
|---|---|---|---|---|---|---|---|---|
| **North Scotland** | 4 | 5 | **20** | 4 | 5 | **20** | | |
| **Central-South England** | 4 | 5 | **20** | 4 | 5 | **20** | **HIGH** | ► |
| **SSEN Overall** | **4** | **5** | **20** | **4** | **5** | **20** | | |

**AR11 Sub-stations affected by flash flooding due to increased winter rain**

Flash floods are generally localised and do not necessarily occur on recognised flood plains. Although extensive damage can occur this is usually restricted to secondary distribution substations. SEPD has a strategic stock of plant and cables to cover such events. Local flash flooding is more likely in climatic terms and also in impact terms in the more urban, hotter and wetter southern region.

| AR11 | Likelihood 2020 | Impact 2020 | 2020 | Likelihood 2050 | Impact 2050 | 2050 | Confidence Level | Trend |
|---|---|---|---|---|---|---|---|---|
| **North Scotland** | 4 | 5 | **20** | 4 | 5 | **20** | | |
| **Central-South England** | 4 | 5 | **20** | 4 | 5 | **20** | **HIGH** | ► |
| **SSEN Overall** | **4** | **5** | **20** | **4** | **5** | **20** | | |

**AR12 Sub-stations affected by sea flooding due to increased sea levels and/or tidal surges**

Sea flooding is specific risk to coastal areas, but the southern regions are projected to be affected more severely. Submerged cables could also be at risk by growing coastal erosion. The type of incident would have similar effect to river flooding except the volumes of water are potentially far greater with more widespread flooding, greater damage to infrastructure and a longer recovery period. The large natural variability has a greater impact on the local North Sea wind field than potential anthropogenic-induced trends. For the North Sea region, including our regions in Scotland, reliable predictions concerning strongly wind- influenced characteristics such as local sea level, storm surges, surface waves and thermocline depth are still impossible.

| AR12 | Likelihood 2020 | Impact 2020 | 2020 | Likelihood 2050 | Impact 2050 | 2050 | Confidence Level | Trend |
|---|---|---|---|---|---|---|---|---|
| **North Scotland** | 4 | 5 | **20** | 4 | 5 | **20** | | |
| **Central-South England** | 4 | 5 | **20** | 4 | 5 | **20** | **HIGH** | ► |
| **SSEN Overall** | **4** | **5** | **20** | **4** | **5** | **20** | | |

**AR13 Sub-stations affected by water flood wave from dam burst**

A dam failure or dam burst is a catastrophic type of failure characterized by the sudden, rapid, and uncontrolled release of impounded water or the likelihood of such an uncontrolled release. Dam burst likelihood or severity does not change ordinarily by regions, but a very specific analysis needs to be done to assess each asset in each region. The 800 dams of Scotland poise a specific risk in this region. Whaley Bridge Dam collapsed, in Derbyshire at 2019, due to lack of maintenance. Most UK dams were built during the 18th and 19th centuries, and specifically the ones in Scotland are prone to suffer inadequate inspection.

| AR13 | Likelihood 2020 | Impact 2020 | 2020 | Likelihood 2050 | Impact 2050 | 2050 | Confidence Level | Trend |
|---|---|---|---|---|---|---|---|---|
| **North Scotland** | 1 | 5 | **5** | 1 | 5 | **5** | | |
| **Central-South England** | 1 | 5 | **5** | 1 | 5 | **5** | **MEDIUM** | ► |
| **SSEN Overall** | **1** | **5** | **5** | **1** | **5** | **5** | | |

**AR14 Overhead lines and transformers affected by increasing lightning activity**

Overhead line systems are exceptionally susceptible to lightning. Lightning storms are projected to occur more due to climate change, but confidence level in this phenomenon is low. A research from 2014 suggest that for every 1C of global warming lightning strikes will increase by about 12%, but it is uncertain of the spatial distribution of those storms. On our Southern England network, lighting strikes are the second highest cause of customer interruptions and minutes lost, and in Northern Scotland it is the fifth highest cause.

| AR14 | Likelihood 2020 | Impact 2020 | 2020 | Likelihood 2050 | Impact 2050 | 2050 | Confidence Level | Trend |
|---|---|---|---|---|---|---|---|---|
| **North Scotland** | 2 | 3 | **6** | 2 | 3 | **6** | | |
| **Central-South England** | 2 | 3 | **6** | 2 | 3 | **6** | **LOW** | ► |
| **SSEN Overall** | **2** | **3** | **6** | **2** | **3** | **6** | | |

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

Likelihood of wildfires to rise in the UK due to climate change, where it raises higher in the southern region due to its warmer projected climate and more woodlands in the region. On the contrary, addressing wildfires in Scotland is harder due to its size and population scarcity.

| AR15 | Likelihood 2020 | Impact 2020 | 2020 | Likelihood 2050 | Impact 2050 | 2050 | Confidence Level | Trend |
|---|---|---|---|---|---|---|---|---|
| **North Scotland** | 2 | 3 | **6** | 3 | 3 | **9** | **MEDIUM** | ▲ |
| **Central-South England** | 3 | 3 | **9** | 4 | 3 | **12** | | |
| **SSEN Overall** | **3** | **3** | **9** | **4** | **3** | **12** | | |