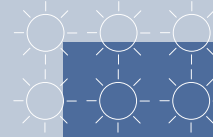


# Climate Resilience Strategy

December 2024



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# 1. Executive Summary

## We are taking action to address four key climate risks

### Impact of warming

- Rising air temperatures, and the increased frequency of heatwaves, are not material to asset operation in the north of Scotland
- Our focus is to improve real time operations to align with prevailing weather conditions
- Active innovation portfolio including dynamic line rating, overhead line ratings and ice mapping

### Frequency of extreme weather events

- Storm events - characterised by high winds and precipitation - are already common in the north of Scotland, but forecast to increase in frequency
- Recent storms (Arwen, Corrie, Malik) demonstrated our response capability to quickly restore the network
- Trees falling on infrastructure is the main risk; we will achieve 100% resilience from falling trees in 2025

### More rain means more flooding

- Increased rainfall, in both quantity and intensity, is material in the north of Scotland intensifying the risk of flooding and landslips
- Flood-related risk assessment of all substation sites is undertaken at least every five years
- Capital investment incorporates flood protection works to projected resilience standards for 2080

### Increased risk of wildfires

- Rising temperature, periods of low rainfall and lightning strikes are increasing the risk of wildfires in the north of Scotland
- Working in partnership with the local Fire and Rescue services on Scottish wildfire danger
- Aligning with global best practice through the International Wildfire Risk Mitigation Consortium

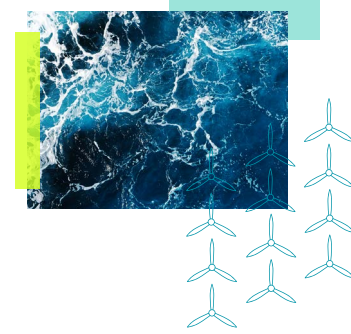
## Accelerating climate adaptation in the RIIO-T3 period

As our understanding of climate risks increases and the fourth National Adaptation Programme is developed, we will evolve our activity:

**Standards** – up-to-date minimum resilience standards across all asset types

- System Impacts** – scenario planning of whole system impacts, cumulative effect assessment, and identifying interdependencies and ‘tipping points’
- Offshore** – with our growing offshore asset base, to increase our capability for offshore climate adaptation

As electricity increases in importance to homes and businesses across the nation, proactive adaptation to climate change is critical to our society and economy.



## 2. Introduction

This document details our climate resilience strategy for the RIIO-T3 period. As a leading Transmission Operator, SSEN Transmission is committed to ensuring a reliable, sustainable, and secure energy supply. However, climate change poses significant challenges to our infrastructure assets, impacting their performance, reliability, and longevity. Rising temperatures, more frequent extreme weather events, and changing precipitation patterns present new challenges to the resilience of our network through increased risk of damage, accelerated wear, and operational disruptions.

We have demonstrated a strong history of responding to and managing climate risk through design and delivery which we will continue to do throughout the RIIO-T3 period. Managing and addressing potential vulnerabilities in our network requires comprehensive risk assessments, resilient design and construction standards, robust maintenance and inspection programmes, improved vegetation management practices, and strategic planning for climate adaptation and resilience measures.

We have developed this Climate Resilience Strategy in alignment with our T3 Business Plan, Strategic Asset Management Plan, and Sustainability Strategy. This strategy is informed by the Energy Networks Association (ENA) 2021 Climate Change Adaptation report<sup>1</sup> which used the UK Climate Projections (UKCP18), from the Met Office, to help us understand and plan for climate change impacts on our assets.

We have completed our risk assessment against the ENA Adaptation Risks and we have considered

a 2022 baseline and a 2050 scenario reflecting a high-emissions pathway<sup>2</sup>. RCP 8.5 is one of a suite of scenarios (Representative Concentration Pathways) that describe several potential future pathways and is the one that has been adopted by the International Panel on Climate Change. RCP 8.5 is consistent with the current pace of global emissions and delivers a temperature increase of 2°C by 2050 and 4.3°C by 2100, relative to pre-industrial temperatures.

Our risk assessment identifies four risks which if not mitigated could impact the operation of our networks:

- **Ambient air temperature impacting overhead lines:** This is managed via implementation of design standards. Cables and overhead conductors are built to international standards, capable of handling more extreme temperatures than those in northern Scotland.
- **Increasing storm conditions:** Both the severity and frequency of storms impacting our network are increasing due to climate change.
- **Flooding of assets:** In RIIO-T2 we have commissioned an extensive flood protection programme, this will continue in RIIO-T3 with a programme of works to undertake flood mitigation works at nine substations, based on the outputs of internal risk assessment and flood modelling.
- **Wildfire:** This is managed via implementation of design standards and supported by enhanced reporting procedure on fires.

We recognise the importance of an enhanced risk assessment and plan to investigate additional scenarios, including later timeframes and different climate

models, to fully understand the long-term impact of climate change. In RIIO-T3 we will develop our understanding of climate risks to our network, invest in future-proofing our assets, and enhance operational flexibility with the aim to build a more robust and climate-resilient transmission network. This strategy identifies the steps we will take during RIIO-T3 to improve our network resilience and understanding of the risks of a changing climate.



<sup>1</sup> **UKCP18 Science Overview Report November 2018 (Updated March 2019)**, Source: Met Office

<sup>2</sup> **Adaptation to Climate Change Task Group Gas & Electricity Transmission and Distribution Network Companies 3rd Round Climate Change Adaptation Report March 2021**, Source: Energy Networks Association

# 3. The Climate Change Challenge

According to UKCP18, the north of Scotland is expected to experience several key climate changes by the end of the 21st century. The most significant predictions for the north of Scotland include:

- **Temperature Increases**
  - **Warmer Winters and Summers:** The north of Scotland is projected to experience a significant rise in average temperatures. By 2080, winter temperatures could increase by around 1-3°C, while summer temperatures could rise by 2-4°C, depending on the greenhouse gas emission scenarios.
  - **Heatwaves:** Although the region traditionally experiences cooler conditions compared to the rest of the UK, there will be more frequent and intense heatwaves, particularly in inland areas.
- **Increased Rainfall in Winter, Drier Summers**
  - **Wetter Winters:** The north of Scotland is likely to see a significant increase in winter rainfall, by up to 20-30% under higher emissions scenarios by 2080. This could lead to more frequent and severe flooding, especially in river valleys and coastal areas.
  - **Drier Summers:** In contrast, summers are expected to become drier, with reductions in rainfall of up to 15-20% in some areas. This could increase the risk of wildfires affecting our network.
- **Increased Risk of Flooding**
  - **Heavy Rainfall Events:** The intensity of heavy rainfall events is predicted to increase, raising the risk of flash floods and river flooding. The north of Scotland is particularly vulnerable due to its topography, with steep hills and narrow river valleys.
  - **Coastal and River Flooding:** Rising sea levels, combined with increased winter rainfall, could exacerbate both coastal and river flooding, threatening our infrastructure.
- **Sea Level Rise**
  - **Rising Sea Levels:** Sea levels around the north of Scotland are projected to rise by 0.1 to 0.6 metres by the end of the century, depending on emission scenarios. This poses a significant risk to coastal infrastructure, increasing the likelihood of coastal erosion and storm surges.
  - **Storm Surges:** In addition to sea level rise, more frequent and severe storm surges could lead to additional coastal flooding, particularly in low-lying areas and small islands.
- **Increasing Wet – Dry Cycles**

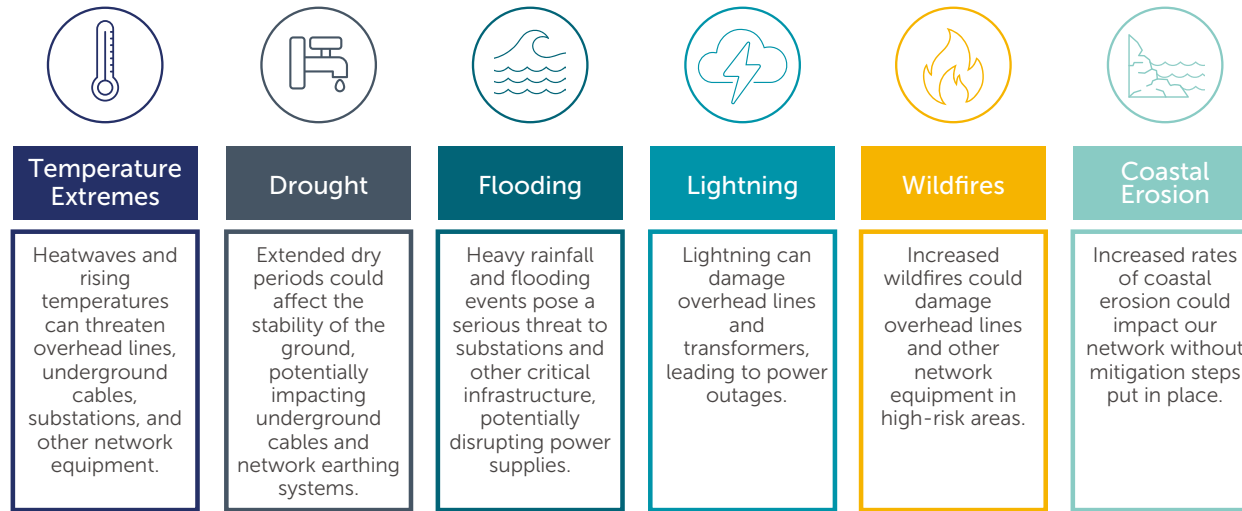
Ground movement caused by drying and shrinkage will exert tensile forces on underground cable systems. Extreme wet-dry and freeze-thaw ground movements will have a similar impact.
- **Increasing Windstorm Events**

Wind Speeds: While overall average wind speeds may remain relatively stable, the north of Scotland could see more frequent extreme wind events, especially during storms, increasing mechanical stress on overhead line (OHL) infrastructure.
- **Impact on Snow and Ice**

The projections suggest that there will be a significant reduction in snow cover, particularly at lower elevations. Mountainous areas may still experience snow, but the duration and intensity of snow cover will likely diminish.
- **Wildfire**

Consequential of increased temperatures and reduced precipitation, wildfire poses a significant risk to overhead line structures, conductors and operational telecommunication systems in susceptible areas such as open heathland.

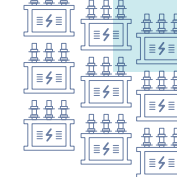
Figure 1: Direct impacts of Climate Change on our Infrastructure Assets



These predictions will also impact on our operational activities due to the interconnections between other industry sectors, such as telecommunications and road transport:

- Road Network: logistics, safe access, response times, supply chain availability.
- Telecommunications Network: operational control, remote operation of equipment, communication with personnel





### 3.1. Climate Change Impact on our Network

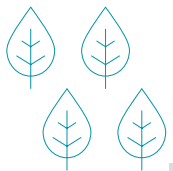
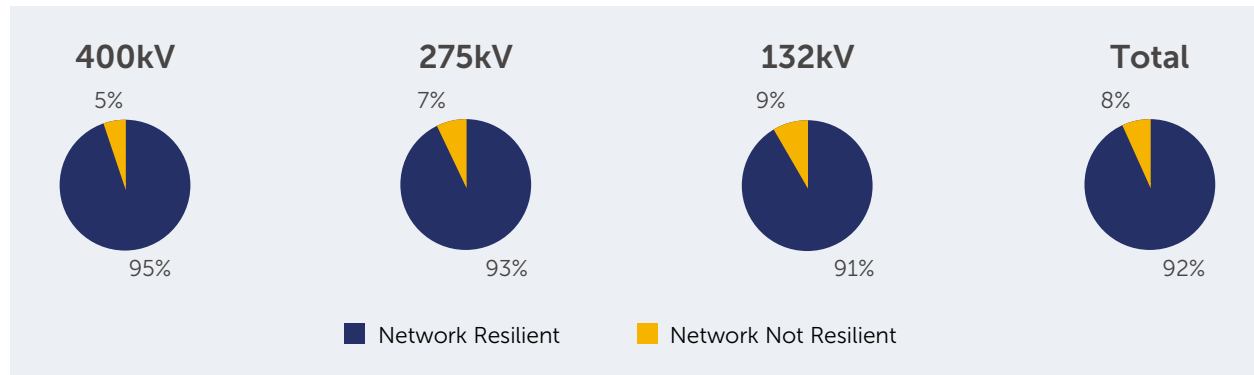
Our transmission network has already been impacted by extreme weather events, such as storms, flooding, and temperature extremes (Table 1). These events highlight the importance of building more resilience into our network and operations to withstand future climate impacts.

**Table 1: Previous Events Impacting our Network**

Date	Event	Impact	Network Materiality
Feb 2018	Beast from the East	This extreme cold wave, driven by the polar vortex, brought significant snowfall and freezing temperatures. The deep freeze and snow disrupted our overhead lines (OHLs) causing localised and temporary outages.	High
2018/19	Icing on OHLs	In 2018 and 2019, we experienced several incidents of ice accumulation on lines, leading to temporary outages and damage.	High/Medium
2019	River flooding	Persistent heavy rain in the autumn of 2019 led to river flooding, threatening the transmission network by eroding land around towers and substations.	Low
2020	Heavy rainfall	In early 2020, heavy rainfall caused localised flooding in parts of the north of Scotland, disrupting access to our transmission infrastructure and delaying maintenance operations.	Low
Nov 2021	Storm Arwen	One of the most severe storms in recent years, Storm Arwen caused widespread power outages across Scotland, particularly in the north. High winds, with gusts exceeding 90 mph, downed overhead transmission lines and damaged critical infrastructure. We faced significant operational challenges in restoring power, with some areas experiencing outages for over a week.	High
Jan 2022	Storms Malik and Corrie	Shortly after Arwen, Storms Malik and Corrie brought further disruption to our network. These storms also brought strong winds, causing widespread damage to OHLs and poles, affecting thousands of customers in the north of Scotland.	High
2022	Heatwave	The UK saw record-breaking temperatures in 2022, putting additional strain on our transmission network. High temperatures reduce the efficiency of our OHLs and transformers, limiting the amount of power that could be transmitted. We assessed and managed the risk of overheating infrastructure during these periods.	Low

Following Storms Arwen, Malik and Corrie we undertook a resilience tree-cutting programme that aims to deliver 100% resilience to falling trees by 2025. Figure 2 shows the statistics for January 2024, with an overall resilience of 92% of our network.

Figure 2: Transmission 'Falling Tree' Resilience Statistics – January 2024





## 4. Climate Risk Identification

Addressing vulnerabilities in our network requires comprehensive risk assessments, resilient design and construction standards, robust maintenance and inspection programmes, improved vegetation management practices, and strategic planning for climate adaptation and resilience measures.

The Energy Networks Association (ENA) 2021 Climate Change Adaptation report identified 15 significant ways climate change could directly impact our operations and assets. These adaptation risks (AR) stem from the various weather phenomena summarised in Figure 1, and are presented as Table 2:

**Table 2: Energy Networks Association Adaptation Risks Summary**

Risk Ref.	Adaptation Risk Summary
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 rainstorms 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.
AR15	Wildfire - Overhead lines and underground cables affected by extreme heat and fire smoke damage.

Our approach to climate risk identification is enhanced through real-time operational improvements and active innovation initiatives. We maintain a dynamic portfolio of innovation projects focused on network resilience, including:

- Dynamic Line Rating (DLR) systems that optimise transmission capacity based on actual weather conditions
- Advanced overhead line rating methodologies that account for varying environmental conditions
- The RIME (Ice Mapping) project, developed in collaboration with the UK Met Office, which will deliver updated ice mapping capabilities by March 2025

These innovations enable us to better understand and respond to climate risks while maintaining optimal network performance under varying conditions.

# 5. Climate Risk Management

We have completed a risk assessment against the AR and we have considered a 2022 baseline and a 2050 scenario reflecting a high-emissions pathway (UKCP18 RCP 8.5). RCP 8.5 is one of a suite of scenarios (Representative Concentration Pathways) that describe several potential future pathways and is the one that has been adopted by the International Panel on Climate Change. RCP 8.5 is consistent with the current pace of global emissions and delivers a temperature increase of 2°C by 2050 and 4.3°C by 2100, relative to pre-industrial temperatures.

Due to the diversity of the hazards identified in the ENA 2021 report we have undertaken an additional assessment of the risks (Table 3) to prioritise those which pose the highest risk to our network assets and provide an appropriate focus for management of those risks.

Due to the long-term nature of the impact of these Climate Resilience risks we intend that the risk assessment is updated on publication of any revised ENA Climate Change Report, UKCP updates, independent scenario modelling and learning or changes in regulation, and should be no greater than every 5 years in preparation for new RIIO price control periods.

## 5.1. Existing Controls

We understand the climate adaptation risks (Table 2) we face, and our network is designed to address them through the application of our current suite of technical and design specifications. Where additional actions are required to address adaptation risks, specific mitigation measures are summarised in the following sections, with Table 3 providing a summary of risks and mitigations.

### 5.1.1. Ambient air temperature impacting overhead lines (OHL)

Our cables and overhead conductors are designed and manufactured to international standards, and consequently these assets are designed to operate safely in much greater maximum

and minimum temperature ranges than those found in the north of Scotland.

High Temperature Low Sag (HTLS) conductors are being introduced to our network but there are not currently any drivers to invest ahead of need to offset the risks.

The assessment team determined that snow/ice loading parameters, applied to our OHL designs, would be reassessed for validity in future reviews of this document. This would allow technical specification changes to be implemented for any future OHL construction or refurbishment works, possibly utilising existing technical parameters applied to OHL design in countries like Norway and Sweden, where ice accretion is currently a higher risk factor than in the north of Scotland.

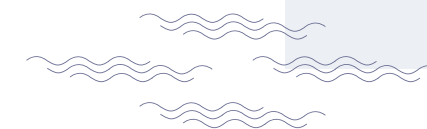
To facilitate future assessments, a Network Innovation Project was commissioned in 2022, to map the impact of lower temperatures across our licence area. This project, Ice Mapping (RIME), is being developed through collaboration with the UK Met Office and is expected to deliver an updated Ice Mapping output by March 2025, in advance of the refresh of this document.

### 5.1.2. Flooding of assets

Increased rainfall, both in quantity and magnitude, has been assessed as a medium risk to the resilience of our network. Increased rainfall has the potential to cause damage to our overhead line, cable and substation assets, requiring mitigation strategies to be developed.

In 2019 we commissioned a risk assessment of all our substation sites by Environmental Resources Management Ltd. 26 sites were considered high risk against projected water table levels for the period 2040-2080.

Our RIIO-T2 project, 'Flood Works', was commissioned to undertake an extensive flood protection programme to provide physical protection and network reconfiguration to minimise



disruption from localised flood events at all the sites considered high risk. Completion of this programme will complete in T3.

Further modelling was completed in November 2023 to inform our future investment programmes as these higher risk assets reach end of life. This will ensure that fully flood resilient solutions are in place by 2040-2060. Technical Standards and the ENA document ETR138 are also in place to ensure that all new network development is undertaken with fully compliant flood resilience to projected 2080 forecast levels.

Our RIIO-T2 project, 'Emergency Planning and Contingency Response', was commissioned to procure a quantity of temporary OHL towers that could be deployed at short notice to restore an OHL to service as soon as it was safe to do so. This project is currently being delivered and will result in the capability being in place by March 2026 to manage any future landslide incidents impacting transmission.

### 5.1.3. Increasing storm conditions

Increasing storm conditions in Scotland are putting significant strain on the transmission network. More frequent and severe storms, linked to climate change, could cause significant damage to overhead lines and substations. High winds can topple trees onto lines or damage pylons directly, while flooding can affect ground-based infrastructure.

Our response capability has been thoroughly tested and proven through recent severe weather events. During Storms Arwen, Corrie, and Malik (2021-2022), we demonstrated our ability to rapidly mobilise resources and restore power to affected areas. These events provided valuable insights that have informed our resilience strategy:

- Emergency Response Enhancement: Improved coordination between field teams and control centres
- Resource Mobilisation: Strategic positioning of emergency response equipment and personnel
- Communication Protocols: Enhanced stakeholder communication during extreme weather events

A cornerstone of our storm resilience strategy is our vegetation management programme. We are on track to achieve 100% resilience from falling trees by 2025 through:

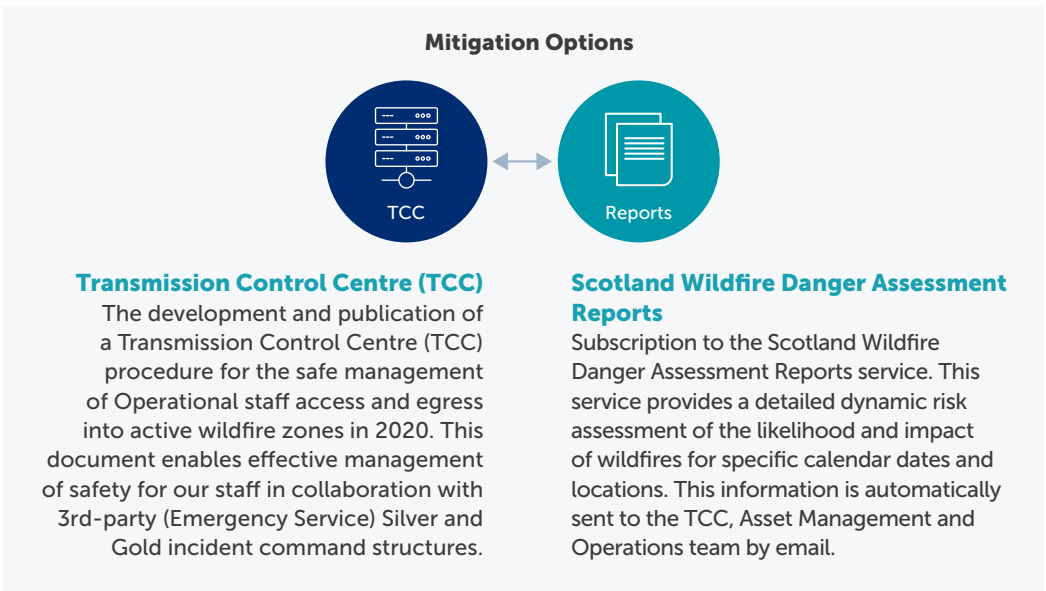
- Targeted tree-cutting and vegetation management in high-risk areas
- Enhanced corridor management practices
- Regular aerial and ground-based infrastructure inspections

- Collaboration with landowners and environmental stakeholders

### 5.1.4. Wildfire

Wildfires pose significant risks to electrical networks, impacting both infrastructure and service reliability. As climate change increases the frequency and intensity of wildfires, the risk to electrical networks is expected to grow.

Mitigation options developed and implemented to manage the impact of this risk include:



In addition to these mitigation options, our Asset Management and Operations Team within Transmission maintain a watching brief on the International Wildfire Risk Mitigation Consortium, run by UMS Group from the USA, to understand the growth and maturity of practical wildfire mitigation strategies employed on higher wildfire risk networks in the USA and Australia.

Asset Management and Operations continue to record the instances of wildfire incidents that impact our assets and network and will consider the statistics for future mitigation options should this risk significantly impact the resilience of our network.

Table 3: SSEN Transmission Climate Risk Assessment

	Impact	Likelihood	Risk	Impact	Likelihood	Risk	Trend	Existing Controls	Impact	Likelihood	Risk
Risk	2022			2050					Residual Risk (Now)		
AR1	4	5	20	4	5	20	↔	Technical and design specifications. Use of High Temperature Low Sag conductors or taller support structures	4	2	8
AR2	2	2	2	2	2	2	↓	Design specifications	2	2	2
AR3	3	3	9	2	3	6	↓	Vegetation management programme. Clearance specification <a href="#">ETR132</a>	3	2	6
AR4	5	2	10	4	2	8	↓	Design specifications	4	1	4
AR5	1	2	2	1	2	2	↓	Design specifications	1	2	2
AR6	3	2	6	3	2	6	↔	Design specifications	3	1	3
AR7	2	2	4	2	1	2	↓	Technical and design specifications	2	1	2
AR8	2	2	4	2	1	2	↓	Technical and design specifications, load planning	2	2	4
AR9	2	3	6	2	1	2	↓	Technical and design specifications	2	1	2
AR10-12	4	5	20	4	5	20	↔	Engineering Recommendation <a href="#">ETR138</a>	4	2	8
AR13	5	1	5	5	1	5	↔	Technical and design specifications	5	1	5
AR14	2	3	6	2	3	6	↔	Technical and design specifications	2	2	4
AR15	4	5	20	4	5	20	↔	Technical and design specifications	4	2	8

Scoring based on the ENA 3<sup>rd</sup> Round Climate Change Adaptation Report – March 2021

## 5.2. Requirements for Additional Controls

Our current control measures are sufficient to manage the identified climate risks in the short term. To determine what and when additional controls are required to manage future climate risks on our network, we need to gain further specific insight and understanding.

Additional control measures may include beneficial adaptation actions such as engineered solutions, nature-based solutions, new or emerging technologies, research and development, and behavioural change.

## 5.3. System-Wide Climate Adaptation Initiatives

As we move into the RIIO-T3 period, our climate adaptation approach is evolving to address emerging challenges through three key focus areas:

1. **Enhanced Resilience Standards**
  - Development of comprehensive, up-to-date minimum resilience standards across all asset types
  - Integration of climate projections into design and maintenance specifications
  - Regular review and updating of standards based on emerging climate science
2. **System Impact Assessment**
  - Implementation of detailed scenario planning to understand whole-system impacts
  - Assessment of cumulative effects across multiple climate variables
  - Identification of critical interdependencies between different parts of the network
  - Analysis of potential 'tipping points' where climate impacts could cause cascading system effects
3. **Offshore Capability Development**
  - Specialised adaptation strategies for our growing offshore asset base
  - Enhanced monitoring and maintenance protocols for marine environments
  - Development of offshore-specific emergency response capabilities
  - Integration of marine climate projections into asset management strategies



# 6. Our T3 Climate Resilience Investment Proposals

We have demonstrated a strong history of responding to and managing climate risk through design and delivery which we will continue to do throughout the RIIO-T3 period.

To ensure network resilience within a changing climate, we recognise the importance of an enhanced risk assessment and plan to investigate additional scenarios, including

later timeframes and different climate models, to fully understand the long-term impact of climate change. As part of our T3 Business Plan, we will aim to consider the latest information on climate risks and undertake scenario planning so we can plan and adapt our mitigation responses to future events. A summary of our climate resilience investment proposals for RIIO-T3 are presented in Table 4.

**Table 4: RIIO-T3 Climate Resilience Investment Proposals**

Scheme Name	Ofgem / Internal Reference	Description	Budget Allocation	Value £m
<b>Enhanced Flood Resilience</b>	SHT20561/ T3BP-EJP-034	Undertake flood mitigation works at nine substations, based on the outputs of internal risk assessment and flood modelling.	NLRE	45.31
<b>Climate risk assessment and reporting</b>	N/A	Undertake basement sealing works at 55 Substations, based on the outputs of internal risk assessment and historic records of flooding at sites.	CAI	0.25
<b>Climate tipping points assessment</b>	N/A	Resource and consultancy support to build on global best practice standards to assess and report on physical and transition risks to SSENT, including but not limited to assets. Additional resource to participate in Ofgem working groups.	CAI	0.15
<b>Climate resilience strategy update</b>	N/A	Develop partnerships with other TOs, academic institutions and others to explore climate tipping points and cumulative impacts in climate risk assessments	CAI	0.1

Dependent on the outcome of the enhanced climate modelling and assessment we will seek to utilise the Climate Resilience Reopener within T3 to address any priority risks identified. In essence our RIIO-T3 Climate Resilience Delivery Plan is live and will be reviewed continually in T3 in response to findings from climate modelling and unplanned

## 6.1. Opportunities and Challenges

Our non-load (core and non-core) and load investment strategies support our commitment to building in climate resilience through interventions on our assets. For example, the construction of additional operational depots across the network will reduce our emergency response time to climate events, and new or replacement assets will have climate resilience inherent to them.

However, with the volume of work being managed by our business in T3 any projects arising from our current climate resilience investment proposals will be competing for resources (e.g. project management and supply chain). Depending on the outcome of a risk assessment, some of these projects may need deferral to RIIO-T4, increasing transient risks.



## 7. Review & Improvement

Under this strategy, performance indicators and monitoring mechanisms to track the effectiveness of climate resilience measures over time are to be defined and incorporated. As various climate resilience metrics and indicators are established, we will determine how and where these should be reported externally, for example in Annual Sustainability Reports or in Annual Reports alongside financial information.

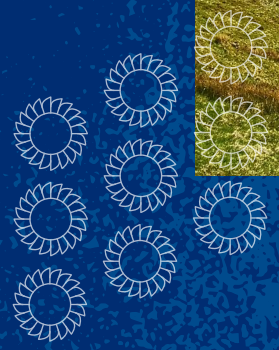
Teams will regularly review and update the Climate Resilience Strategy in response to new information, changing climate conditions, and lessons learned from implementation. This review will feed into the planning for RIIO-T4 and demonstrate our commitment to continual improvement.



## 8. Stakeholder Engagement

We are establishing strong collaborative relationships with advisory, expert, external and internal stakeholder groups in the development and delivery of our climate resilience strategy. Stakeholder led improvements will be reflected in successive governance, policy, strategy, and process revisions, and ensure our activities continue to meet stakeholder requirements and deliver our corporate objectives.





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