nationalgrid

Annex 02

RIIO-T3

Climate Resilience Strategy

National Grid Electricity Transmission's Business Plan

December 2024

Overview of this document

Purpose of this Annex

All energy infrastructure is at risk from weather events such as changing temperatures, winds, lightning and flooding. Models show that extreme weather will become more frequent, increasing risk. This document sets out our ongoing investment in climate resilience and the impact of our role as responsible guardians of critical national infrastructure (CNI).

The commitments and ambitions set out in this document reflect stakeholder expectations for the RIIO-T3 period and will guide strategic investments including in asset health, digital and our workforce.

The objectives of this document, in line with Ofgem's Business Plan Guidance, are to:

- Explain how this document relates to our other climate-related disclosures
- Detail our assessment of the latest climate change risks and their evolving impact on our network
- Demonstrate how we have mitigated these risks and how we will continue to do so during the RIIO-T3 period in line with our strategic objectives
- Evidence our resilience by outlining case studies related to high impact, low probability weather events
- Discuss barriers to climate resilience investment and our mitigation of those barriers

In addition to this strategy, we prepare a number of documents which relate to climate resilience. These include the reports we prepare to comply with the National Adaptation Reporting and the Taskforce for Climate Related Financial Disclosures (TCFD), and our existing internal Climate Change Adaptation Strategy. Taking note of Ofgem's guidance to avoid duplication where possible, we have referred to these documents where there is further information to support our Climate Resilience Strategy.

How to navigate this Annex

The table below provides a short summary of each section and where information requested in the Business Plan Guidance has been provided.

Section	Detail	BPG reference[1]
1	**Executive Summary**	n/a
2	**NGET climate resilience and adaptation strategy** – Outlines the objectives of our strategy and how it has been informed by stakeholders	5.12
3	**NGET climate risk assessments and reporting** – Sets out our risk assessment methodology and the role it plays in determining the impact of climate change on our network. Also outlines our latest Climate Change Adaptation Report (ARP4)	5.8; 5.12; 5.13; 5.14
4	**NGET investments in climate resilience** – Presents our RIIO-T3 climate resilience investments and signposts the relevant Investment Decision Packs (IDPs)	5.10; 5.11; 5.13; 5.17
5	**Recent weather events and impact to our network** – Case studies of recent extreme weather events to demonstrate the historic resilience of our network and explain how lessons learnt inform our policies	5.15; 5.16
6	**Barriers to climate resilience investment and mitigation actions** – Identifies barriers to investment such as data availability, industry standards, workforce skills and interdependencies, and how we will mitigate these through our partnerships, innovation and asset upgrades	5.20

[1] These are the BPG requirements relevant to this Annex. These requirements may also be addressed in other business plan submission documents.

Our RIIO-T3 objectives and commitments

Our plan is anchored around three ambitions, each underpinned by clear objectives, commitments and success measures for the RIIO-T3 period. These allow us to target stretching levels of performance and track progress. The specific ambitions, objectives and commitments that are most relevant to this annex are shown below:

Our Plan Objectives		Our Commitments: We will:		Success Measure / Target
A1	Maintain world class levels of network performance and resilience, and ensure that the new network we build is designed to reflect future security and climate challenges	A1.1	▸ Ensure our assets continue to provide a resilient network, delivering high quality and reliable electricity to consumers	▸ 99.9999% network reliability ▸ <135MWh per year Energy Not Supplied
		A1.2	▸ Not allow the overall risk of our network to increase, as we deliver across multiple drivers (network growth, safety, resilience and environment)	▸ Maintain asset risk at RIIO-T2 levels whilst the network grows more than in previous periods
		A1.3	▸ Build upon delivery of climate resilience mitigations already developed with new and innovative modelling capability and refreshed standards	▸ All new sites resilient by design ▸ New resilience modelling approach implemented and Climate Adaptation Strategy published by 2026

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1. Executive Summary

Our maturity in climate resilience has moved significantly through the RIIO-T1 and RIIO-T2 periods, in-step with an increasing maturity across the sector and wider scientific community. To date, our primary focus has been on retrospective flood risk mitigation. Our surface water flooding risk investment plan tackled the most significant risk posed by climate change to our network at the time. It was guided by the Energy Networks Association's "Engineering Technical Report 138" which was established following the significant floods of 2007, and the subsequent by the Pitt Review and the Government's response[2][3].

By the end of the RIIO-T2 period, we will have concluded a successful investment programme in flood defences. This will transform a network that was built to standards defined largely in the 1960s and 1970s, into one that is resilient against a climate that has changed considerably in the time since. These investments are an essential consideration for any new additions to our asset portfolio. They underpin our monitoring efforts for ongoing effectiveness.

As we enter RIIO-T3 in 2026, we will continue to transition into a new phase of climate adaptation. The following strategic objectives demonstrate a shift from a more-retrospective approach and towards an increasingly dynamic, forward-looking approach, supported by the latest technologies. As part of our climate resilience strategy we will:

1. Set Smarter Targets for Resilience

We plan to continue to conduct comprehensive risk assessments that allow us to identify vulnerabilities and manage them in our overall risk management process. We will then establish monitoring systems to track the effectiveness of adaptation measures and report on outcomes to stakeholders.

2. Embed Resilience in Network Design and Operations

Our network requires investment to ensure the installed assets remain resilient and to grow it to meet Government decarbonisation targets. These assets, including our new substations, support buildings, and overhead lines, will be built to the latest global standards. This approach ensures we embed resilience from the outset, meaning we deliver this resilience at zero or very low incremental cost. It also eliminates the need for a significant standalone investment plan for climate resilience in RIIO-T3.

We will also regularly update and drill emergency response plans to ensure quick and efficient action during climate-related incidents.

3. Explore Innovative Solutions

We are developing our forecasting capability in response to the evolving nature of climate science. This will enable us to appropriately understand and mitigate emerging risks early across a range of future climate scenarios.

This year we updated our latest climate change adaptation risk assessment and are publishing it as part of the UK's ongoing National Adaptation Programme. Our previous report identified flooding, coastal erosion, and rising temperatures as the most significant risks to our network over the next 10 years. To date, our efforts have focused on these risks in different ways, and in RIIO-T3 we have an increased focus on coastal erosion.

Our latest report, outlined in Section 3, includes projections for 2100 and has an updated view of relevant mitigations to both ongoing and emerging risks. We will invest in research and development of new technologies to enhance infrastructure resilience and improve our digital capabilities, so we are able to utilise predictive modelling to support incremental investment in climate resilience.

We will be installing sensors to collect real-time data and utilising existing tools to provide new data insights that will come to define our climate adaptation pathways. Our digital investments and innovation projects throughout RIIO-T3 will be essential to reducing the uncertainty posed by long-term climate projections, understanding lower severity climate risks and to removing barriers to investment in climate resilience. These are outlined in detail in Section 4.

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[2] Engineering Technical Report 138, Energy Networks Association, 2018
[3] Government response to the Pitt Review, 2008

4. Support Systemic Adaptation

We will work closely with government agencies, local communities, and other stakeholders to develop and implement effective climate adaptation strategies. As we have in RIIO-T2, we will continue to advocate for supportive policies and regulations that promote climate resilience and adaptation.

Through all of this we will collaborate with wider industry on resilience standards, climate resilience projects and research. This will mark a continuation of our work with groups like the Energy Networks Association, Climate Change Committee, distribution operators and academia that ensure we are identifying whole system risks and mitigations. We will also reinforce our relationship with the National Energy System Operator (NESO) in recognition of their role moving forward and how essential their position will be to ensure climate resilience across the whole energy system and beyond.

Recent, devastating weather-related events have only further demonstrated that without proactive investment, research, and industry coordination in climate resilience, we could face irreparable consequences to our national infrastructure. The above strategic objectives reflect our commitment to meet this challenge head on, for our customers, and for the future of energy security in the UK.

Conclusion

During the RIIO-T3 period, we will be embarking on a comprehensive programme of upgrades and expansion to our network, driven by the decarbonisation of the energy system and asset health replacement of life expired equipment. These investments will be developed and delivered under the principle of ‘resilient by design,’ ensuring our infrastructure meets the latest standards to minimise incremental costs and reduce likelihood of retrospective investments in the future.

We are committed to leading the way in setting climate resilience standards across our industry. It is crucial that we get this next period right to accurately estimate the level of investment required for future price control periods. Recent storm activity has demonstrated the robustness of our network against current risk profiles, and future risk assessments indicate the need for ongoing updates to design standards as our understanding of risks evolves.

In partnership with the NESO, we are responsible for safeguarding critical infrastructure at the heart of the global shift towards a Net Zero target to mitigate climate change risks. We are prepared to meet this challenge head-on, with the commitments outlined in this document and the support of our industry partners.

2. NGET Climate Resilience and Adaptation Strategy

Key Points:

- Our Responsible Business Charter was updated in 2023 and sets out our commitment to make our operations and network resilient to climate change.
- This commitment is reflected in our internal Climate Change Adaptation Strategy (CCAS), developed according to ISO14901 standards.
- Our CCAS is an internal strategy that forms the basis of all external reporting on climate adaptation, including this document.
- We will work with key stakeholders, including Ofgem, to bring this together into one overarching climate strategy while also considering how we best report on additional elements that Ofgem require in this annex that would not typically form part of our adaptation strategy e.g., cost information from events.

How do we define resilience for NGET?

The ability of the electricity transmission network in England and Wales to withstand disruptive events, and the organisational capability of NGET to reduce the magnitude and/or duration of disruptive events. This includes the capability to anticipate, absorb, adapt to and/or rapidly recover from such events thus ensuring that electricity continues to reach consumers safely, reliably, and efficiently.

2.1. Reflecting the commitments set out by our Responsible Business Charter

Our Responsible Business Charter was launched in 2020 and describes what responsibility means to us and the targets we have in place to achieve a fair and affordable energy transition, whilst also reducing our impact on the climate.

In 2023, we refreshed our charter to ensure that it reflects the latest expectations placed on us by stakeholders. Under our first pillar, 'Our Environment', lies our commitment to adapt to a changing climate and to report on this:

Responsible Business Charter Commitment 4: Adapt to a changing climate

Report on our climate change risks and opportunities and our investment in climate change adaptation activities.

By proactively addressing climate risks and enhancing infrastructure resilience, NGET aims to safeguard operations and continue providing reliable electricity to our customers.

A full overview of our Responsible Business commitments and performance is available in the Responsible Business Charter and Responsible Business Report[4].

The success of this commitment is measured against the implementation of our Climate Change Adaptation Strategy, published internally in line with ISO14091 standards.

2.2. Our Climate Change Adaptation Strategy

Our Climate Change Adaptation Strategy was developed to address a principal business risk surrounding a requirement to demonstrate a strategy for climate resilience. It builds upon the delivery of climate resilience mitigations already in place (i.e., flood mitigation) and demonstrates our commitment to ensuring the reliability and sustainability of our electricity transmission network in the face of climate change[5].

[4] Responsible Business Charter and Responsible Business Report.
[5] More detail about our network load strategy can be found in Annex A08: ET Load Strategy

It also provides a framework for climate adaptation within NGET's internal procedures and informs our external climate change Adaptation Reporting Power (ARP) publication against suggested targets set by the Climate Change Committee (CCC). In the future, it will form part of any ISO14001 accreditation audits. The following strategic objectives are defined by our strategy and have been used to guide our plan for RIIO-T3, including the content of this annex:

1. Set Smarter Targets for Resilience

- Conduct comprehensive risk assessments that allow us to identify vulnerabilities and manage them in our overall risk management process.
- Establish monitoring systems to track the effectiveness of adaptation measures and report on outcomes to stakeholders.

2. Embed Resilience in Network Design and Operations

- Upgrade and reinforce existing infrastructure to withstand extreme weather.
- Regularly update and drill emergency response plans to ensure quick and efficient action during climate-related incidents.

3. Explore Innovative Solutions

- Invest in research and development of new technologies to enhance infrastructure resilience.
- Utilise predictive modelling to support incremental investment in climate resilience.

4. Support Systemic Adaptation

- Work closely with government agencies, local communities, and other stakeholders to develop and implement effective climate adaptation strategies.
- Advocate for supportive policies and regulations that promote climate resilience and adaptation.

These objectives are reflective of our ambition to maintain a resilient network by making targeted, well-informed investments into climate adaptation that reflect our latest understanding of risk.

2.3. Our approach to climate resilience reflects what stakeholders have told us

Throughout Autumn 2023, we hosted a series of regional events to hear feedback on what stakeholders felt to be the most important outcomes that we could deliver for them in the coming years. Some key insights from those discussions directly correlate to this strategy.

When asked to rank energy security/reliability, sustainability, and affordability, 41% of respondents ranked energy security and reliability as the most important in the energy trilemma.

Additionally, consumers emphasised that network resilience must come without passing on the cost to their bills. By contrast, the majority of impacted stakeholders responded that they would support us ensuring the network is resilient to external factors even if it was not expected to reduce customer bills in the long term[6].

In 2024, we shared our Climate Resilience Strategy with our Independent Stakeholder Group (ISG). The ISG supported our approach of targeted, research-led investment. They advocated for NGET to continue sharing our knowledge across the utility sector. They also challenged us to further develop and enhance our stakeholder engagement approach, focusing both on how we are thought leaders for the sector while also learning and sharing experience with international network companies.

Ultimately, all the groups that we talked to agreed that we should prioritise developing the network according to anticipated future needs such as climate adaptation.

[6] Impacted stakeholders is our definition for parties such as local authorities, industry, other sectors

3. NGET climate change risk assessments and reporting

Key Points:

- Our risk assessments are based on a risk methodology developed with the Energy Networks Association and other TOs.
- Our climate change risk profile has evolved over four rounds of reporting to now include an assessment for 2100, noting a high degree of uncertainty in how risks will manifest in the long term.
- The most significant hazards posed to our network over the next 25 years are rising temperatures, coastal erosion, and flooding – an assessment that has remained consistent over previous rounds of reporting.

In this section we set out our risk assessment methodology, and the role it plays in determining the impact of climate change on our network by **'setting smart targets for resilience'**. We will also outline at a high level our latest Climate Change Adaptation Report (ARP4), published alongside this document, which utilises UK Climate Projection data[7] (UKCP18).

Our commitment

A1.2

Not allow the overall risk of our network to increase, as we deliver across multiple drivers (network growth, safety, resilience and environment)

3.1. Background to UK Climate Resilience

Climate science that has been well understood for many years now indicates that changes to our environment are inevitable. The latest climate projections for the UK are set out in the Met Office's climate change projections known as UKCP18. They form the basis of adaptation reporting and risk management by national agencies. Whilst the next round of projections is due to be published in 2026, after we have developed this plan, we do not expect a significant change in current strategy as a result but will keep this under review.

To provide assurance, the Energy Networks Association (ENA) commissioned the Met Office in 2020 to undertake a review of UKCP18, highlighting that the following hazards were those which were the highest risk for energy network assets:

- Prolonged rainfall leading to flooding.
- Extreme high temperatures.
- Heavy rainfall/drought cycles.

The inevitability of these risks has prompted a response from governments and industry alike to adapt and implement resilience by design.

3.2. UK National Adaptation Programme (NAP)

In 2008, the UK Climate Change Act set out a five-year reporting cycle for climate change risk assessments, forming the basis for the country's ongoing action plan to adapt to climate change.

The Adaptation Reporting Power (ARP) enables the UK Government to request reports from critical infrastructure providers on the current and predicted effects of climate change on their organisation; their proposals for adapting to climate change; and progress made towards their implementation. The ARP is a key element of the adaptation policy cycle and provides a unique source for understanding the UK's infrastructure-related climate risks.

NGET was an early participant in the first ARP reporting cycle, ensuring that each reporting cycle forms a solid foundation for understanding industry wide climate-related challenges and the corresponding resilience of our network.

Those risk assessments provided as part of the UK's National Adaptation Programme (NAP) are set out in this resilience strategy and provide the foundation for our action plan into RIIO-T3 and beyond.

In March 2023, the Climate Change Committee (CCC) published its latest report on the UK's adaptation efforts. The energy industry was determined to have made 'mixed' progress towards their

[7] UK Climate Projections (UKCP) - Met Office

sector specific targets but commended transmission companies on the progress they had made with their climate adaptation strategies[8].

More recently the CCC published their proposed methodology for their fourth independent climate change risk assessment which will inform the UK's updated National Adaptation Programme (NAP)[9]. In their publication, the CCC outlined three key priorities for NAP4:

1. Increase cross-government collaboration.
2. Tackle barriers to investment.
3. Improve monitoring and collection of data.

NGET has taken steps to ensure these priorities are embedded within this strategy – supporting governmental collaboration by highlighting the innovation, digitisation and asset health improvements required to mitigate climate risk.

A key mechanism for unlocking these priorities remains with setting industry-wide resilience standards. A recent analysis by the National Infrastructure Commission (NIC)[10] acknowledges that whilst there are existing standards in the energy sector, there is still a lack of definition when it comes to long term resilience of the network. As one of our strategic objectives '**Support Systemic Adaptation',** we are committed to supporting the development of these standards to overcome uncertainties and barriers to investment, partnering with a strong network of industry and cross-industry actors.

3.3. Taskforce on Climate-Related Financial Disclosures (TCFD)

NGET has disclosed against the TCFD since 2017/18 and our disclosures now cover each of the TCFD's recommendations and recommended disclosures around governance, risk management, strategy and metrics and targets. NGET contributes to the annual TCFD disclosure by demonstrating how the business is responding to climate change. This is through case studies such as Ofgem funded net zero innovation projects, performance against our GHG emissions targets and examples of how extreme weather events have impacted NGET networks to outline the long-term risks and opportunities associated with climate change.

With the transfer of TCFD responsibilities to the International Financial Reporting Standards (IFRS) Foundation we are now working towards compliance with International Sustainability Standards Board (ISSB) by FY27 and will continue to report on progress through our annual reporting.

In it's final status report, published in 2023, the TCFD remarked that *"estimating potential financial impact from climate change requires expertise from different functions within a company. As a result, it may be useful to set up a cross-functional team for such efforts"*[11]. This statement reflects our commitment to break down siloes in the continued support of industry resilience standard development.

3.4. How we assess and calculate risk to our network

Climate adaption and mitigation activities to address our physical risks are embedded into our core business processes. Our Chief Risk Officer leads the development of climate adaptation frameworks across the National Grid Group (including NGET) to ensure there is a consistent approach to assess the vulnerability of our energy assets and to guide strategic investment planning to ensure network resilience.

Further delegation is given to our core operational businesses including Business Unit Presidents who are accountable for delivering the net zero roadmaps for their businesses. Corporate Affairs, Group Finance, Sustainability, Safety & Health and People teams support the businesses in achieving their net zero pathways.

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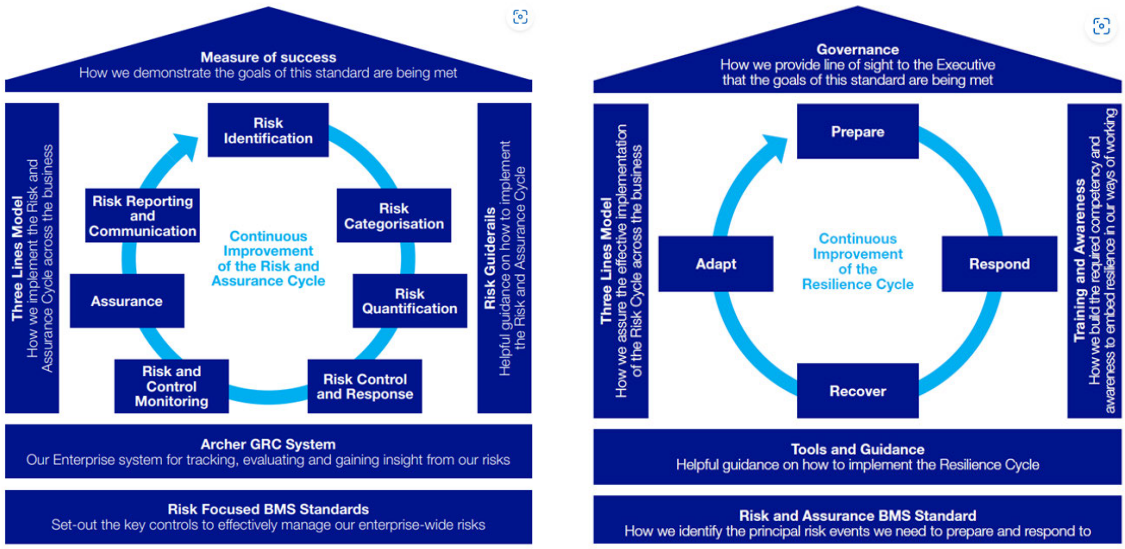
[8] March 2023 Progress in adapting to climate change 2023 Report to Parliament (theccc.org.uk)
[9] Proposed methodology for the Fourth Climate Change Risk Assessment - Independent Assessment (CCRA4-IA) - Climate Change Committee (theccc.org.uk)
[10] https://nic.org.uk/app/uploads/NIC-Resilience-Standards-Report-Final-190924.pdf
[11] 2023-Status-Report.pdf (bbhub.io)

NGET has resilience standards in place to ensure the continuity of services we provide to our customers and the communities we serve.

The Risk and Assurance Standard is used by NGET to anticipate and respond to threats and opportunities, thereby successfully delivering our strategy and objectives.

The National Grid Business Resilience Standard drives continual improvement in the way we prepare for, respond to, recover and adapt from significant business disruptions.

Figure 1: NGET Resilience Approach



These standards are high level approaches that in themselves do not specifically address climate change hazards and require consideration alongside the below risk matrix.

3.4.1. Climate Change Adaptation – Risk Matrix

Our climate change adaptation risk matrix is derived from our adaptation reporting. It is co-ordinated by the ENA and is used cross-industry to provide consistent messaging throughout our reporting. Each hazard is assigned a risk rating using the relative impact and likelihood of that climate hazard.

The full risk ratings are presented in Appendix A.

Figure 2: Risk Matrix

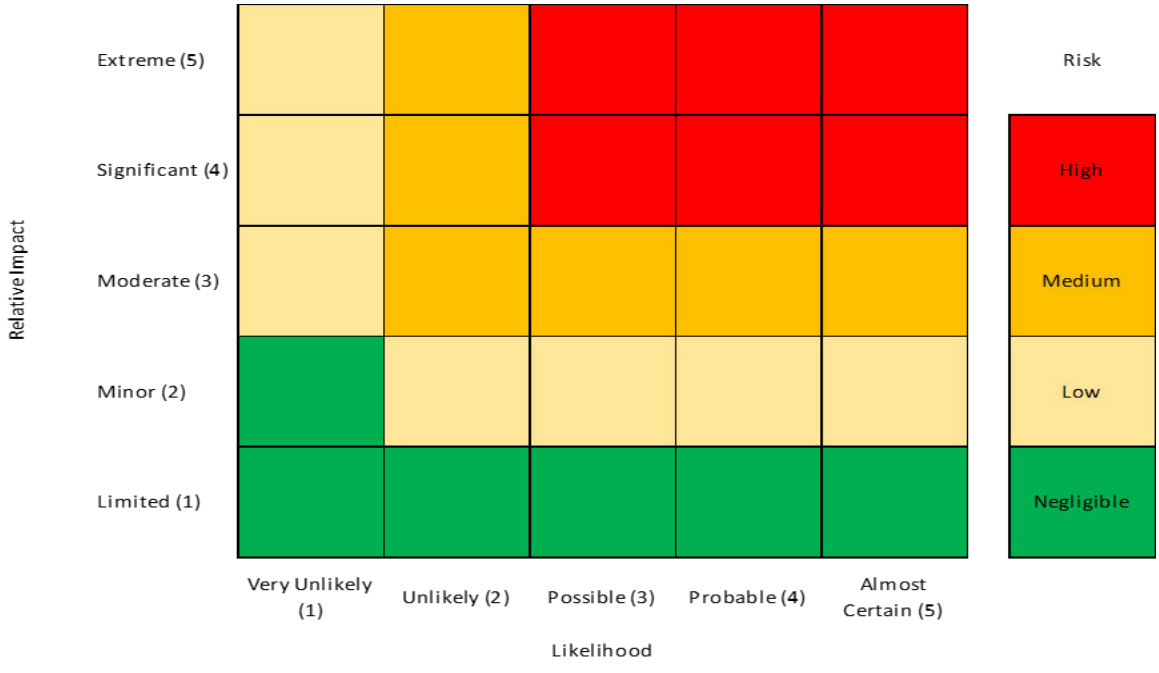


Table 1: Definitions of impact and likelihood ratings

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	Country or city area affected with people off supply for a week or more OR asset de-rating requires a significant re-prioritisation of network reinforcement and deferment of new connection activities
Moderate	Large town or conurbation off supply for up to a week OR significant increase in cost of network strengthening
Minor	Small town off supply for a 24-hour period OR significant increase in cost of network maintenance requirements
Limited	Limited impact - can be managed within “business as usual” processes

Likelihood Rating	Definition
Almost Certain	The risk is expected to be realised 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

3.5. Our Latest Climate Adaptation Report (ARP4)

3.5.1. Background to our latest report

Our third round of adaptation reporting was based on a review of the UKCP18 data commissioned by the ENA from the Met Office. As a result of the updated data, we took the opportunity to undertake a full reassessment of climate risks - reviewing 86 potential risks and narrowing them down to 50 priority risks for closer management.

Our objective for ARP3 was to:

- Provide an update on existing risks and mitigation measures described in the previous reports.
- Identify new or emerging risks to provide a comprehensive picture of the potential for climate change impacts to affect NGET; and
- Incorporate the latest climate information provided by UKCP18.

UKCP18 uses several emissions scenarios known as Representative Concentration Pathways (RCP). These RCPs signify various concentrations of greenhouse gas emissions and their resulting effect on global mean surface temperatures.

We chose to risk assess our assets and processes against the low emission scenario (RCP4.5) for the baseline assessment and the high emissions scenario (RCP8.5) for ARP3. ARP4 also uses RCP8.5 for its assessment of 2100, which we are publishing in December 2024.

This was on the basis that should our assets and processes demonstrate resilience against the higher RCP8.5 scenario i.e., extreme outlier events, it would inevitably be adapted against lower and more likely climate changes characterised by RCP4.5.

Table 2: Emissions scenarios

RCP	Increase in global mean surface temperature (°C) by 2081-2100	NGET adaptation reporting usage
4.5	2.4	Baseline (2024)
8.5	4.3	2050, 2100

The methodology and objectives outlined above for ARP3 have been carried forward for ARP4, with the scope as outlined below.

3.5.2. Our fourth round of adaptation reporting

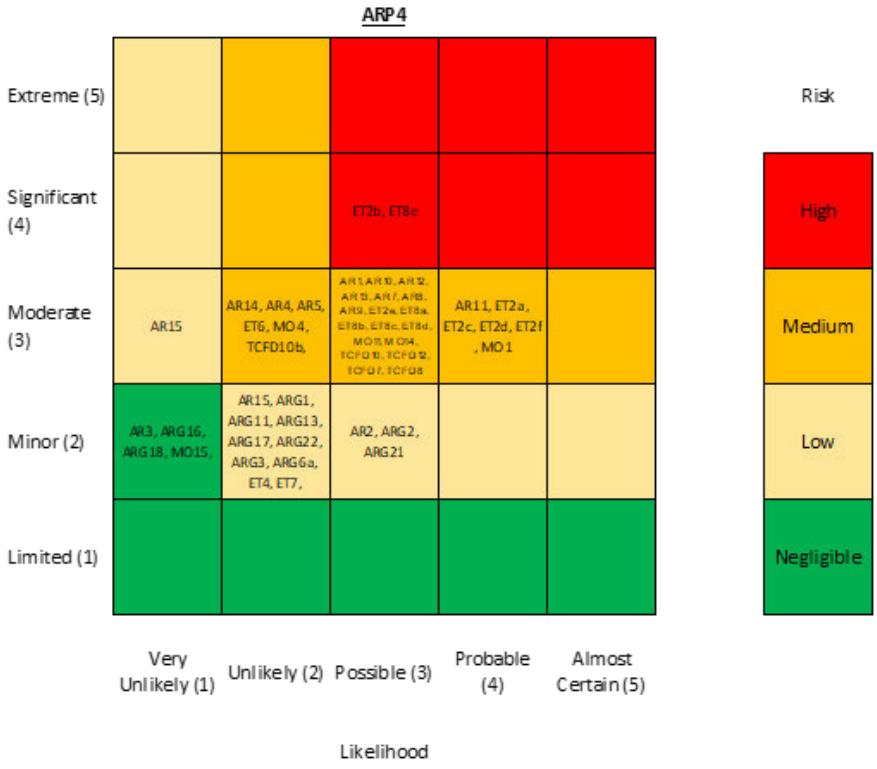
Following consultation, the UK Government brought forward the fourth round of adaptation reporting to better align with the publication of the UK Climate Change Risk Assessment by the CCC. As this is a shorter cycle, occurring in parallel to the publication of our Climate Resilience Strategy, we have relied on ARP3 to form the basis of our assessment. ARP4 expands on ARP3 by providing a focus on mitigation progress, interdependencies, and future climate risk.

For the first time we have provided a 2100 profile using RCP8.5 to demonstrate where we believe the most significant threat will be posed by climate change in the long term. We have retained the use of RCP4.5 and RCP8.5 for the baseline and 2050 scenarios respectively.

The risks identified in the report are presented in groups, repeated here in this Climate Resilience Strategy to aid in identifying them when they are referenced. The codes presented relate to National Grid gap analysis and the ENA Climate Change Adaptation Sub-Group, namely:

- AR: ENA Climate Change Adaptation Reporting Group Electricity Risks.
- ARG: ENA Climate Change Gas Adaptation Sub-Group.
- GT: Gap Analysis between National Grid Gas Transmission and National Grid Electricity Transmission.
- TCFD: Risks considered by the TCFD Working Group Climate Modelling, but not considered in previous ARP Reports.
- MO: Risks considered by the Met Office Report, but not considered in previous ARP Reports.

3.5.3. ARP 4 Risk Matrix



3.5.4. ARP 4 High Climate Adaptation Risks

Table 3: High Climate Adaptation Risks

Code	Risk	ARP3	ARP4	2050	2100
ET2b	Coastal Management Policy	3x4	3x4	4x4	4x4
ET8e	Flooding from Storm Surges	3x4	3x4	4x4	4x4

The two highest risks identified by our ARP4 assessment remain the same as our ARP3 assessment. These risks are related to impacts on the coast, one due to the impact of natural processes and the second, linking with coastal management policy. They are:

- **Coastal Management Policy (ET2b)**: The potential impact of policy on asset and asset management from changes in coastal management.
- **Flooding from Storm Surges (ET8e)**: The impact of coastal flooding compounded by sea level rise, erosion and tidal influences.

The nature of flooding risk requires a cycle of review and reassessment by the Environment Agency. The management of flooding risks, including from sea level rises, is written into our core business policies and procedures, and adherence to ETR 138, a recognised energy sector standard. This ensures sufficient protection for a 1 in 1000 year flood event for transmission substations, with those impacted under review based on latest research and climate projections.

However, where possible, we would seek to locate new sites away from sea level risk and coastal flooding risk areas.

We are undertaking a research and innovation project (ICECREAM – see Section 4) to understand the long-term risks posed to coastal and estuary assets. Many medium and long-term shoreline management plans entail the creation of salt marsh habitats, some of our tower routes run through or are close to these areas and this together with increased coastal storm activity are likely to lead to increased saline pollution reaching further inland.

Further detail on how we will continue to mitigate these risks by **exploring innovative solutions** is set out in Section 4.

3.5.5. ARP 4 Medium Climate Adaptation Risks

The highest tier medium risks identified in ARP4, having a 'probable' likelihood and 'moderate' impact (4x3) rating have remained unchanged from ARP3. They include:

Erosion:

Code	Risk	ARP3	ARP4	2050	2100
ET2c	Riverbank Stability and Scour	4x3	4x3	4x4	4x4
ET2d	Groundwater & Geohazards	4x3	4x3	4x4	4x4
ET2f	Surface Water Runoff Scour	4x3	4x3	4x4	4x4

Foundations of OHL towers and cable routes can be undermined by riverbank erosion, subsurface flow, and surface water runoff. More frequent flooding and increased river and watercourse flows will increase this level of risk.

Plans are in place to respond to the most credible emergency scenario, e.g., erosion and destabilisation of OHL tower foundations. In this instance, loss of any one double circuit would not normally result in loss of supply.

This risk is increasing its impact on the network, although it has a more transient effect than more permanent changes seen at the coast. Research was undertaken during RIIO-T1 that identified potential risk areas, which may be more vulnerable to these impacts during the coming decade.

Sites at flooding risks are dealt with and discussed in the flooding risk section of our strategy. For sites not at risk of flooding, the legacy drainage systems were installed many years ago and their performance design standard is unlikely to meet current specifications and struggle to cope with draining sites during 'normal' very heavy rainfall. While this may not pose a threat to supply, the

increased frequency of extreme rainfall events will likely place additional strain on the aging drainage systems which is likely to result in an increase in maintenance and failure repair.

We have identified the tower and cable assets which are in areas of increased susceptibility to erosion and monitor these sites closely. We assess the towers in erosion prone areas to determine whether investment in managing the erosion risks is required as part of planned refurbishment works.

We have based our assessment of assets located in areas of increased vulnerability to erosion and water driven geohazards on the British Geological Surveys (BGS) Geohazard datasets and the Environment Agencies long term flooding risks[12].

Fortunately, most issues are relatively small and can be managed under BAU maintenance works. We are undertaking works to separate this previously invisible climate change adaptation driven cost, so we can ensure future regulatory submissions reflect this potential increasing workload expenditure.

It is likely that investments in managing erosion and geohazard will continue to increase year on year to continue to meet our objective of **embedding resilience in network design and operations** and it is anticipated that any increased maintenance costs will be funded.

We also undertook a piece of work with Liverpool University to better understand our exposure to riverbank erosion and our assets. Using Environment Agency (EA) river gauge data this work looked at potentially monitoring and forecasting erosion rates where our tower assets are located in proximity to areas of riverbank particularly susceptible to erosion. Counting the number of 'normal' and extreme flood events with the frequency of occurrence. Implementation of this monitoring process will be assessed through the RIIO-T3 regulatory period.

Ground Movement:

Code	Risk	ARP3	ARP4	2050	2100
ET2a	Geohazards	4x3	4x3	4x4	4x4

Ground movement risks are increasing primarily due to changes in the water cycle driving higher than normal water table and near surface water levels. The increase in appearance of sinkholes and washouts demonstrates this risk is growing.
We have assessed our assets against the BGS's geohazard and the EA's flooding risks datasets to identify those assets in risk areas. We have developed weighted risk banding scores for all tower and cable joint bays to identify those assets in risk areas. This data is used to inform our maintenance and route refurbishment works.
In most cases, the assets foundations in an identified risk area have been designed to cope with the sites geohazard conditions. For example, piled foundations for towers in marshland. The difference between today and when assets were installed is the increased fluctuations of groundwater levels and near surface flow rates.

Pluvial Flooding:

Code	Risk	ARP3	ARP4	2050	2100
AR11	Substations affected by pluvial (flash) flooding due to increased rainstorms in Summer and Winter	4x3	4x3	4x3	4x3
MO1	Increased intensity of short duration rainfall leading to flooding	4x3	4x3	4x3	4x3

These risks are closely linked to risk ET8e and the flooding investment plan we have carried out throughout RIIO-T1 and RIIO-T2. More information on this is outlined in Section 4.
Below is a full list of our 'medium' risks identified in ARP4. More detail on these risks and their mitigations can be read in the full report[13].

[12] https://www.bgs.ac.uk/geological-data/datasets/
https://www.data.gov.uk/dataset/42c31542-228d-439b-8dbe-e72135dae71c/flood-risk-areas
[13] Our environmental plan and performance | National Grid ET

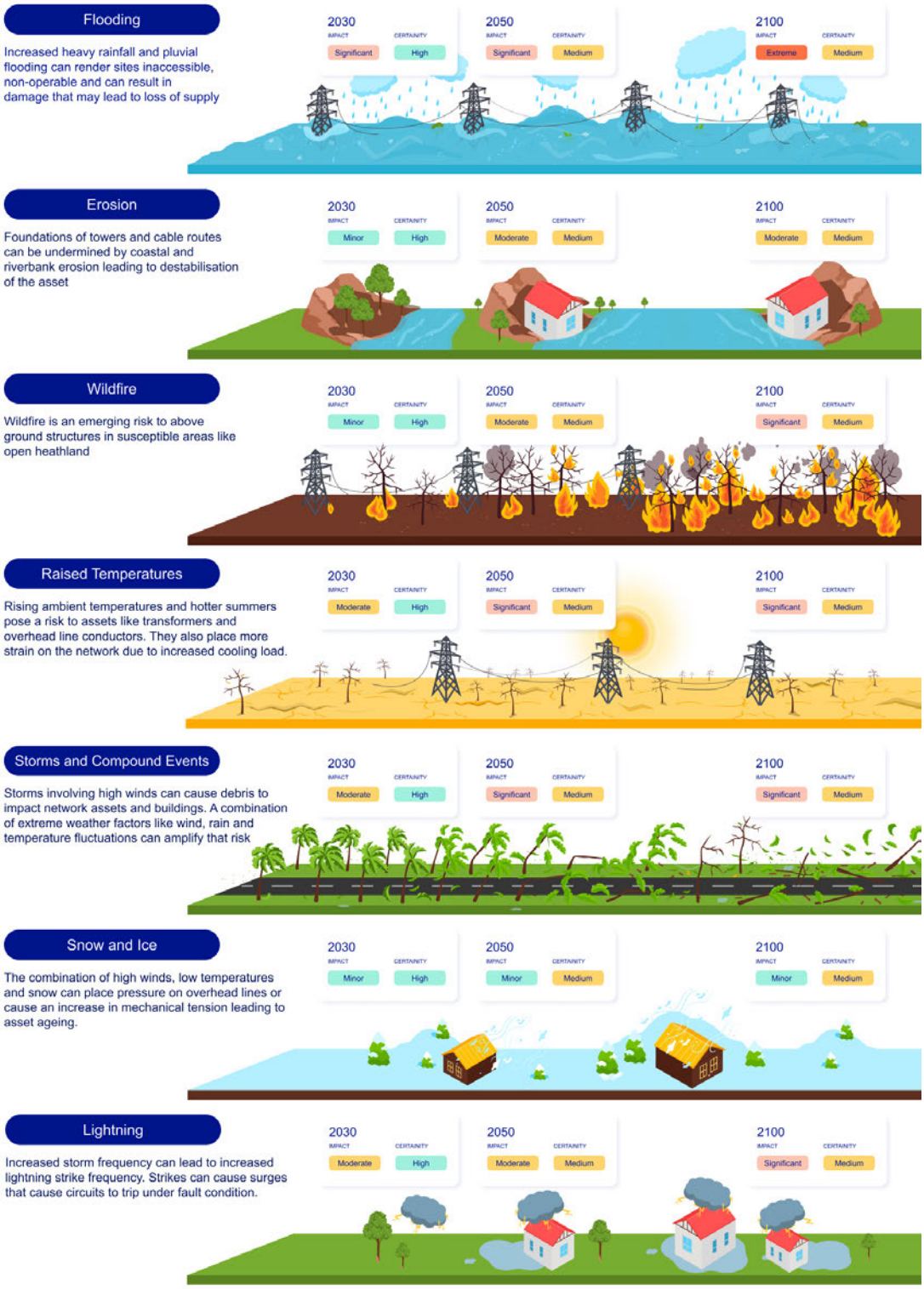
Table 44: ARP4 Medium Risks

Grouping	Code	Risk
Compound Events	TCFD7	Extreme weather events including a combination of wind, rainfall, temperature or snow
	TCFD8	Perfect Storm of a cold winter, high electricity demand and heavy persistent rain
Erosion	ET2c	Riverbank Stability and Scour
	ET2d	Groundwater & Geohazards
	ET2f	Surface Water Runoff Scour
Fluvial Flooding	AR10	Substations affected by river flooding due to increased winter rainfall
	ET8a	Fluvial river and coastal flooding of NGET sites
	ET8b	Fluvial river and coastal flooding – neighbouring sites leaving NGET sites stranded
	ET8c	Shifting flood areas may affect existing sites in the future
Ground Movement	AR5	Underground cable systems affected by summer drought and consequential ground movement,
	ET2a	Geohazards
	ET2e	Landslips, slope stability, ground creep, avalanche
	MO 4	Repeated Cycles of drought and rainfall
	TCFD 10b	Increased rate of loss of level in areas with already low depth of cover (e.g., Fenland area)
Inter-dependencies	AR13	Substations affected by water flood wave from dam burst
	ET8d	Reservoir / Canal Failure
Lightning	AR14	Overhead lines and transformers affected by increasing lightning
Pluvial Flooding	AR11	Substations affected by pluvial (flash) flooding due to increased rainstorms in Summer and Winter
	MO1	Increased intensity of short duration rainfall leading to flooding
Raised Temperatures	AR1	Overhead line conductors affected by temperature rise.
	AR4	Underground cable systems affected by ground temperature increase
	AR7	Transformers affected by temperature rise
	AR8	Transformers affected by urban heat islands and coincident air conditioning demand
	AR9	Switchgear affected by temperature rise
	TCFD10	Demand growth in Summer due to increased cooling load
Sea Level Rise & Coastal Change	AR12	Substations affected by sea flooding due to increased rainstorms and/or tidal surges
Storms	ET6	Severity, Intensity and Frequency of Storms
	MO11	Temperature / Precipitation: Warm and wetter conditions combined with rainfall and / or wind
Temperature Cycles	MO14	Diurnal Temperature Range
	TCFD12	Fast Freeze-thaw cycles

3.6. Climate Change Hazard Evolution Summary

The below infographic summarises the evolution of our climate change risk profile through 2030, 2050 and 2100. It demonstrates the increasing severity of the impact of high-level hazard groupings and the reduced certainty of what impact the hazard may have, the further into the future we project.

Figure 3: evolution of our climate change risk profile through 2030, 2050 and 2100



4. NGET investments in climate resilience (RIIO-T2 and RIIO-T3)

Key Points:

- In RIIO-T2 we will conclude an extensive programme of retrospective flood resilience work, with climate resilience embedded by design in RIIO-T3 through the utilisation of effective policies and standards, and ongoing delivery of our asset management strategy and associated processes.
- Asset data and climate modelling are being combined through innovation projects to produce insights that will support future climate adaptation strategies and investment decisions.
- We will continue to lead and participate in industry working groups with the objective of removing barriers to investment in climate resilience and establishing industry-wide standards, as well as learning from other geographies that may have more experience in particular climate change hazards.
- Our climate Memo Table outlines in more detail the specific investment linkages and dependencies with the rest of the RIIO-T3 plan.

There are several ways in which we have and will continue to invest in climate resilience across our network. These investments are not only related to physical resilience but also encompass business process, collaboration with interdependent industries and innovation projects. They are targeted at significant climate risks where the investment is clearly justified and at improving our understanding of the risks where it is not.

Many of these initiatives are a continuation of work ongoing in RIIO-T2 and we have summarised the RIIO-T3 specific investments at the end of this section. We have also signposted the relevant Investment Decision Packs (IDPs), where appropriate. No other funding mechanisms are in use currently.

4.1. How we are maintaining and increasing the resilience of our network

The nature of our industry and threats posed by climate change mean that our climate resilience strategy relies on a robust maintenance schedule of our physical assets. We are responsible for ensuring that our assets are managed according to the appropriate regulations and technical standards e.g., ETR138. Our previous investments have targeted the risks that flooding and severe weather poses to the network in accordance with our ARP reports.

In RIIO-T3 we will replace assets and expand our network by investing up to £35bn in the period. These assets will be built to the latest standards, meeting our strategic objective of creating a network that is inherently **resilient by design**. Below are a few examples where interventions contribute to improving resilience to our more significant climate risks – flooding, coastal erosion, rising ambient temperatures and wildfire.

4.1.1. Surface water flooding risk investment plan

We have invested in a systematic programme of resilience against flooding risks for over 15 years in alignment with industry-led responses to significant events.

Prompted by the 2007 summer floods, the Energy Networks Association led a sector response to flooding risks to power supplies. The following year, an Engineering Technical Report (ETR138) was published, setting out flooding resilience standards for distribution and transmission substations.

Based on this industry and regulatory combined report, we developed our flood defence Policy Statement and associated Technical Specifications, outlining sites at risk of flooding and enabling a scheme to protect those sites. This assessment allowed us to pinpoint [redacted] of investment in flood defences at [redacted] substations during RIIO-T1 with a further [redacted] committed in RIIO-T2 to complete work across [redacted] in scope sites.

As of summer 2024, a total of [redacted] sites are protected from flooding, including sites which are protected by third party defences and those sites where demountable defences are the current flood protection in place. A further [redacted] sites are in progress, [redacted] sites are under investigation to establish risks, and [redacted] sites are on hold because the site is either being refurbished or the site is planned to be decommissioned. If all sites still under investigation require defences, we will then have protected the [redacted] sites in our original assessment.

Figure 4: NGET Walham substation protected by flood defences

Moving into RIIO-T3, flood defences are no longer a retroactive exercise. Where new sites are being built and extensions being sought across our business plan, resilience is inherent by design. This is the case at our 400kV site at Walpole where an extension in the existing flood plain requires additional defences to be built, incurring close to [redacted] of additional expenditure to ensure that we are resilient to potential floods.

Our process of optioneering for new sites considers both location and designs that avoid constructing sites in high-risk flood zones. For example, the Wanlass Beck (extension to Creyke Beck substation) project team have avoided the existing Flood Zone 2 & 3 outside Creyke Beck substation by ensuring their design and technology choices actively consider the impact on site footprint.

Flood Zone Definition:

Zone 1: Lowest level of risk – 1 in 1000 year risk area

Zone 2: Medium level of risk – 1 in 200 year risk area

Zone 3: High level of risk –1 in 100 year risk area

4.1.2. Reconductoring Overhead Lines

Over the last 25 years of asset health reviews and maintenance schedules, we have transitioned our conductors to a more resilient design. The newer AAAC (all aluminium alloy conductor) technology systems have lower heat losses, higher ampacity and higher maximum operating temperatures (up to 50°C) than the original ACSR (aluminium conductor steel reinforced).

In addition, we also have a High Temperature Low Sag (HTLS) conductor which is mainly used on the older part of the network (L2 towers). These provide much higher ratings (up to 120°C) than the original ACSR conductors, to maximise thermal capacity of the network during high ambient temperatures.

Reconductoring is undertaken due to asset health drivers which, depending on the conductor system used, can support the network to be more resilient against rising ambient temperatures and high temperatures due to wildfire. This climate change risk (AR1) is recognised to be an emerging threat by our latest adaptation report (ARP4). Therefore, the transition ensures that we maintain our resilience in line with the increasing severity of risk.

During the RIIO-T3 period, we plan to reconductor OHLs to meet both load and non-load drivers. Those OHLs which will not be reconductored in the period are still able to operate adequately during above average ambient air temperature and the maximum operating temperature may only be required under fault conditions. Any changes to this, noted as part of regular asset health reviews, will fall into the pipeline for upcoming investments[14].

4.1.3. Replacing/Rebuilding Assets Affected by Erosion

Erosion is an emerging risk to our network, as reported in our latest round of adaptation reporting. As a result, we have conducted surveys of our assets with the British Geological Survey to determine sites at risk from this climate hazard.

One such example of sites at risk is [redacted], a coastal site located within flood zones 2 and 3, making it highly susceptible to flooding. The primary investment driver for [redacted] is related to poor asset health indices.

The existing substation location for both the 400kV and 132kV sites are suffering from subsidence because of sea water ingress and undermining that continue to have a negative impact on both substation buildings, surrounding land, cable tunnels and access routes. Projections suggest rising water levels could lead to potential submersion of the site by 2050.

In RIIO-T3 the proposal is to rebuild [redacted], expected to be at a new, more inland, remote site located within flood zone 1. Rebuilding in this way allows us to implement the latest standards in safe locations, ensuring long-term reliability.

As climate resilience is integral to the design of our solutions, we have not been able to extrapolate the climate related cost of the chosen option and have not included it within the Memo Table.

Further information on this investment is contained in the [redacted] EJP.

4.1.4. Vegetation Management for Storm and Wildfire Risk

Our Business Procedure for the Management of OHL Vegetation sets out the requirements to which we adhere so we can effectively manage vegetation growth around our overhead lines. Effective vegetation management reduces the risk posed by both severe winds during storms and wildfire during heat waves, identified in our ARP reporting as a low risk to our network (ET6, AR15). By managing vegetation growth around critical transmission infrastructure, we are ensuring that debris from falling trees does not damage assets. It also prevents wildfire risks where it may otherwise spread through uncontrolled vegetation growth.

In our RRP submission in July 2024, we reported that spend on vegetation management was forecasted to be [redacted] lower than allowances for RIIO-T2 as the result of [redacted]

In RIIO-T3, we are proposing to continue our investment in vegetation management, based on RIIO-T2 volumes and current framework costs to the total of [redacted]. The cost will include activities such as regular inspections, risk assessments and clearances, ensuring compliance with our business procedures.

4.1.5. Marine Cable Resilience

A key component of our future network is offshore cabling, connected to coastal assets, that improve the reliability of supply throughout the UK.

Our proposed work in RIIO-T3 will build on the experience from the installation of Western Link, the result of a joint venture with Scottish Power Transmission, that currently provides a 262-mile link between Scotland and Wales and contributes to security of supply.

Offshore climate change risks such as rising sea levels, increased storm activity and the potential for changes to the seabed environment all have the potential to affect the resilience of these assets. The use of High Voltage Direct Current (HVDC) technology also poses some new technological resilience

[14] More detail about this can be found in Annex A08: ET Load Strategy

considerations as these require carefully controlled environments, for example housing and environmental controls for our new HVDC converters. In addition, HVDC systems have uni-directional electric fields that cause greater accumulation of contaminants on insulators; hence we are carefully considering the insulation class, inspection, and maintenance regimes to avoid the increased risk of flashover.

Whilst there is still a high level of uncertainty as to how climate change risks to offshore cable will continue to manifest in the future, there is currently not enough evidence to justify a change in existing design standards that already demand an appropriate level of resilience.

HVDC and marine cable technology being deployed through ASTI are a 'first of a kind' in the UK. Our inspection & monitoring philosophy will be a combination of continuous and risk-based methods, to permit us to determine when interventions are required. Our learnings from the operations at Western Link, and the wider deployment of HVDC assets around Europe, will allow us to continuously improve and adapt our approach. We will also undertake rigorous risk assessments with our installation partners that consider deliverability, availability, reliability considering the evolving risks associated with climate. The outputs of these assessments will be analysed by our internal marine and cable subject matter experts who will ensure any standards, like our flooding resilience standards, need to be applied.

4.1.6. Expanding Our Digital Capabilities and Understanding of Climate Science

Along with the maturation of our physical network, we are also actively engaging in the development of forecasting capabilities so we can appropriately mitigate risk and assess the need for future investment against **smarter targets.** We will achieve this through the implementation of new digital capabilities and **exploring innovative solutions** in collaboration with industry partners.

4.1.7. Advancing our digital capabilities to support climate resilience

As part of our broader submission for RIIO-T3, we have a number of projects that will support both holistic resilience and climate resilience moving forward. As outlined in the Climate Resilience Memo Table, [redacted] of the relevant projects will be specifically supporting the integration of climate resilience modelling and analysis within a number of digital products through the RIIO-T3 period.

The areas relevant to climate resilience include the Group-led Climate Change Risk Tool (CCRT) with [redacted] of CAPEX, as well as our digital papers on Power Systems Analysis and Modelling, Building Information Modelling (BIM) and Network Control. They will support holistic decision making for incident response and network design processes, including climate resilience. Except for the CCRT, these investments do not only deliver against climate resilience so only a proportion has been allocated, the detail of which is outlined in the Memo Table narrative. The allocation of costs is [redacted] of Power System Analysis and Modelling, [redacted] of BIM and [redacted] of Network Control.

This will enable us to:

- Target climate risks that are less understood in terms of their impact to the network.
- Evidence ongoing cost benefit analysis for investment in climate resilience.
- Understand the effect of high impact, low probability events on our network.
- Minimise the impact of extreme events by enabling reactive controls.

These investments are described in more detail in Annex A05: Digitalisation Strategy and Action Plan, Annex A13: IT and Telecoms and EJP: General Counsel.

4.1.8. Building our understanding of coastal and estuarine risks with new sensors

Erosion and chemical reactions on network assets can cause failure in transmission towers, collapse or inaccessibility. In addition, shoreline management plans and coastal management strategies will be implemented by local and regional authorities, causing some coastal areas to change in ways that make it impractical or impossible to keep infrastructure in those locations over the next several decades.

Project ICECREAM is a RIIO-T2 project funded by the Network Innovation Allowance (NIA). It aims to assess how different conditions and risks such as higher sea levels, coastal storms and increase in salt deposition is damaging assets such as towers. ICECREAM will implement new cameras and sensors, gathering real-time data to develop national-scale, multi-hazard assessment of the risks

posed by flooding and erosion to transmission assets. The initial scope of the project will include [redacted] in coastal areas around England and Wales (initial phases being implemented in Liverpool).

Costal Management Policies are ranked as one of our highest impact climate risks over the coming decades (see Section 3). By investing in projects like ICECREAM we therefore aim to:

- Improve our understanding of the impact of coastal erosion on our network.
- Increase data availability to monitor asset health and identify critical risk moments with real-time alerts.
- Enable cost benefit analysis and mitigation measures that maintain network resilience.

The outcome of this project will inform BAU resilience measures throughout RIIO-T3, including updates to risk assessments and options analysis. Based on this, we will be able to develop an appropriate resilience strategy for erosion management into future price control periods.

4.1.9. Improving data availability to simulate extreme weather conditions

At present there is not a clearly defined, tested and validated approach to gain a comprehensive understanding of how extreme temperature events can influence the network. In addition, climate hazards are often assessed in isolation when in fact they have the potential to occur at the same time, raising the risk of cascade failures to an exposed network.

Whilst there has been modelling development to quantify component (mainly OHL and cables) aging due to temporary heating (from loading mainly), the analyses do not extend to rapid weather changes with simultaneous loading fluctuations.

Through Project THERMAL, a RIIO-T2 NIA funded project, we are developing a new tool that will allow us to simulate extreme weather events and the impact that they may have on our network. The project will run till 2025 and produce a model that could test ‘what if’ worst case scenarios, quantify risk and help identify the most resilient technologies.

In turn, we will be able to use this data-first approach to inform future investment strategies, business continuity plans and our evolving climate adaptation strategy.

4.1.10. Improving our severe weather alerts tool with new data sets

This year, we completed a wildfire threat assessment with the University of Birmingham. The assessment looked at 20 years of wildfire reports in the UK, the type of land on which the wildfire occurred and the location data of NGET’s assets.

It concluded that the assets most at risk of wildfire were those located on farmland and open heathland. From that we were able to extrapolate a list of the top 10 of circuits at risk of being impacted by wildfire. This has informed vegetation management and responses coordinated by our business continuity plans.

In RIIO-T3, we are planning to take the learnings from this assessment and establish a live monitoring of wildfire risk alongside flooding and coastal erosion in our severe weather alerts tool (SWAT2). This will allow us to compile evidence for any increasing risk to NGET’s network over the coming price control period and to formulate any required mitigations in the form of future investment.

4.1.11. Improving Access to Climate Data – Insights Hub

We created our Network Resilience Insights Hub in 2023. The aim of the Hub is to improve the resilience and visibility of the HV Transmission Network by providing:

- Easily accessible data for field teams and asset design teams
- Visibility of the overall resilience of the Transmission Network
- Easy identification of high-risk assets and locations

The hub is live and available to all our staff to view at any time.

Figure 5: Network Resilience Insights

An example of how the Insights Hub is used for climate resilience is with our Delayed Auto Reclose (DAR). DAR is a mechanism through which a circuit is automatically re-energised following a transient fault like a lightning strike during a severe weather event. If these DARs are unavailable, this raises the risk of a circuit not being restored automatically leading to additional down time. By making available the relevant data sets through our insights hub we can identify high resilience risk DARs and execute more strategic interventions, given the challenges around system access.

The development of our Insights Hub to inform proactive maintenance on DARs has proved to be a successful risk mitigation for lightning. Throughout RIIO-T3, we will use the data gained from the insights hub to continue to inform proactive maintenance or asset upgrades. DARs provide a useful indicator of places on the network that are more susceptible to lightning based on how often they are deployed. Exploring how this data can be extrapolated to inform work beyond just maintaining the DARs themselves will be a key RIIO-T3 activity.

4.1.12. Exploring further climate resilience innovation opportunities

In RIIO-T3, we propose to spend [redacted] to explore emerging **innovation opportunities** in relation to climate change. These will look at our highest rated risks and measures to directly respond to them. As the nature of innovation investment is agile, and we recognise that an additional proportion of our innovation fund (in addition to the [redacted]) may be utilised for Climate Resilience work which has yet to be determined or identified. More information on our innovation plan can be found in Annex A09: Innovation.

4.2. Embedding Resilience in Our Workforce

Our investments in asset health and new technologies are critical in supporting the resilience of our network. Alongside the physical infrastructure investment, we are also dependent on having an adequately trained, experienced, capable, well-equipped workforce.

They are trained to recognise the risks posed by climate change, their impact on BAU processes and the actions we can take to alleviate them. Their knowledge and commitment are also critical to enact operational processes during extreme weather events to maintain business continuity.

Throughout RIIO-T3, we will increase the size of our resilience team by up to eight resources. Some of these resources will be dedicated towards managing our ongoing assessments of asset design vulnerabilities so that they can be updated against our 2050/2100 risk profiles. We will also ensure that we continue to minimise the risk to our workforce posed by the climate.

4.2.1. Protecting our workforce from climate related risk

We have a mature ISO45001 accredited health and safety management system, relevant policies, standards, procedures and training. In preparation for future risks and opportunities we are currently undertaking a root and branch review to ensure we continue to meet all safe operational goals and that our processes are user-friendly at the point of delivery.

Emerging risks including regulatory changes, technological advances, and climate challenges demand a proactive approach. Workforce growth and new sectors like our marine cable projects offer chances for innovation and improved safety in these areas.

In order to minimize risk to personnel during severe floods, we use data from sensors at our sites to help determine whether it is safe for people deployed to that site or whether remote monitoring needs to be carried out. We also use risk assessments as part of our work order process to determine whether heat poses a risk to our people when undertaking work during summer months.

4.2.2. Deploying Business Continuity Plans in response to severe weather

We also have a mature ISO22301 accredited Business Continuity system part of which embeds Management Review of our resilience planning and implementation.

For climate resilience this commitment is enshrined in our Incident Management Framework Business Procedure (BP) 118, specifying our initial response and recovery from incidents on our network. Under this framework falls our Extreme Weather Business Continuity Plan which sets out how our control centre will manage risks associated with extreme weather events.

In recent years we have utilised this approach frequently, particularly given the high volume of named storms through winter 2023/24. We also exercise specific teams to test their capability and enable us to derive lessons learned to improve our overall resilience position.

For example, in July 2024 NGET led an extreme weather resilience training exercise with our South-East Substations & Cables team. The exercise was kept unknown to those involved and incorporated over twenty players including all the relevant Substation Operations Managers. The exercise focused on the lead up to storm event, with the team proactively reviewing their simulated outage plan, identifying mitigating site actions and assets to be returned to service. This was all whilst responding to new simulated faults and constraints across the network.

The exercise was part of our ongoing adherence to the ETBP118 Incidence Management Procedure. By carrying out a real-life simulation of an extreme weather event we were able to demonstrate the preparedness of our business considering increasing weather-related incidents due to climate change. The exercise focused on a scenario of strong wind and rain, giving managers a certain amount of warning to prepare and put in place mitigation measures. Throughout the remainder of RIIO-T2 and into RIIO-T3 we will continue to expand our programme of simulations to other regions and incorporating lessons learned into our ongoing plans and procedures for managing incidents.

4.3. Collaboration within National Grid and Our Industry Partners

The risk posed by flooding to transmission owners provides a leading example of industry collaboration and technical standard agreement. Following ETR138, we were able to evidence a decades-long investment strategy resulting in a successful set of measures to protect the network against climate change.

Interactions with our industry partners play a crucial role in shaping our understanding of future climate risks, increasing awareness of climate change-related legislation, and comprehending the intersectionality of climate change impacts.

For example, as a transmission owner operating in the UK, we collaborate with the ENA to produce its ARP report. In this way, we are able to provide an assessment of climate risk that uses consistent metrics accepted by other industry partners including Distribution Network Operators (DNOs). Through the ENA we have also been able to collaborate with the Met Office who produced an updated assessment of the UKCP18 in 2021 and provided assurance in available climate data against which we assessed network risk.

By staying connected with external stakeholders, we ensure that our strategy aligns with industry best practices, regulatory requirements, and the evolving and complex landscape of climate change impacts.

Throughout RIIO-T3, we will further expand on these partnerships, including our engagement with other TOs, to ensure that we meet our strategic objective of '**support systemic adaptation**' throughout the next few years.

The table below provides an overview of the key stakeholders with an interest and/or role in implementing elements of this strategy. Ongoing contributions and engagement with the stakeholders have supported:

- Developing a shared understanding of current and future risks.
- Sharing knowledge and best practice.
- Providing updates with government and regulators.
- Development of our ARP submission to Defra.
- Engaging with Environment Agency to collaborate on works like updating SMPs.
- Participating in external groups and forums relating to case studies and plans.
- Incorporating feedback on price control strategies from our Independent Stakeholder Group.

Table 5: Climate Resilience Stakeholders

Government & Regulators	Internal Stakeholders	External Stakeholders
• Ofgem • Department of Environment, Food & Rural Affairs (Defra) • Environment Agency (EA) • Department for Energy Security and Net Zero (DESNZ) • Department for Science, Innovation and Technology (DSIT) • Climate Change Committee (CCC)	• Group Chief Risk Office • Group Sustainability Office • National Grid Ventures – Interconnectors • National Grid Electricity Distribution	• Energy Networks Association (ENA) • Energy Generation, Transmission and Distribution network providers • Energy Emergencies Executive Committee (E3C) and its subgroups • NESO (National Energy System Operator) • British Geographical Survey (BGS) • Met Office • Electric Power Research Institute (EPRI) • IAM – Climate Emergency Programme • Natural Environment Research Council • Critical National, Regional and Local Infrastructure • Cat 1 and Cat 2 responders e.g., during severe storms

The below infographic summarises our roadmap for climate resilience related investment and assessment over the RIIO-T3 period. Each of these represents a continuation of our work in previous years with focus on new and emerging risks.

Figure 6: Climate Resilience Investment Roadmap

4.3.1. Early engagement on updated policies and data sets for assessing coastal risk

Current shoreline management plans set out the national approach to coastal flood and erosion risk out to 2105. They were developed in the UK between 2006 and 2012 by governmental and local authorities. As part of their remit, the Environmental Agency is continually working to refresh these plans with local authorities and a recent launch of the Shoreline Management Plans (SMP) Explorer has made these a lot more accessible.[15]

Defra have committed to undertake a review of SMPs in the next few years. Depending on whether this review prompts a change in current plans, we will ensure early collaboration with the relevant authority to update our assessment of risk (ET2b).

This in turn will inform monitoring and maintenance schedules of our coastal assets in accordance with the level of risk. Additionally, the outputs of Project ICECREAM will be made publicly available and form part of our contribution to Defra's review.

Additionally, in their updated research briefing[16] the BGS sets out plans to supplement their existing datasets with a broader range of RCPs and time horizons.

In particular, it will account for both RCP4.5 and RCP8.5 which will allow us to explore coastal risk ET2b alongside the outputs from Project ICECREAM and evolving SMPs.

4.3.2. Alignment of geomagnetic weather monitoring with NESO

Space weather or solar flares have the potential to cause physical damage to transmission assets and knock out telecommunications networks that provide essential services for our customers and emergency workers. The UK government rates this risk as 'significant' on the National Risk Register[17], on par with a severe storm lasting for one to two weeks.

Even though this particular risk is not exacerbated by a changing climate, our adaptation reporting includes an assessment of solar storms and concludes the risk to be low (MO15).

The risk to the transmission network is managed by the NESO who recently published a new warning procedure for geomagnetic events. Our resulting business continuity plan, aligned to our Incident Response Framework (ETBP118) accounts for this notifications process and any corresponding requirement to work with the NESO on preparatory activities.

In RIIO-T3, we will continue to support the implementation of this warning procedure and to update any resulting resilience standard uplift.

4.3.3. Monitoring fracking policy impact on ground movement

Another monitoring activity that we will carry out in RIIO-T3 is on policy surrounding fracking activities. In 2016, we undertook an assessment of microquakes and their impact on our network. We found the network to be resilient to the standard level of ground activity in the UK.

However, the potential impact of fracking activities which increase the level of ground movement beyond those expected levels, will necessitate a corresponding level of maintenance to be carried out on impacted assets.

Fracking activities are typically dictated by government policies which have the potential to evolve during the RIIO-T3 price control period.

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[15] SMP Explorer: Digital shoreline management tool launched - GOV.UK
[16] BGS geohazards and climate change - research briefing - British Geological Survey
[17] 2023_NATIONAL_RISK_REGISTER_NRR.pdf

4.3.4. Developing industry frameworks to unlock investment in resilience

Whilst resilience quantification and assessment exist, there is not an industry framework that enables resilience to be embedded into network decision making in a fair and standardised way. This results in a barrier to investment in climate resilience.

Project WELLNESS (Whole Energy System Resilience Vulnerability Assessment) was funded through the Strategic Innovation Fund (SIF) during an alpha phase that addressed this barrier directly by:

1. Bringing world-leading models and analysis methods from academia into an accessible framework for decision makers, with energy networks and industry partners providing a critical role in the consortium.
2. Bringing a diverse cohort of partners together so that our tools represent the whole electricity system.
3. Recognising that advanced modelling and analysis tools must be complemented by a decision-making framework that includes the 'softer' aspects of resilience such as people, policies, standards to deliver comparable and fair investment decisions.

The first phase of this project completed in RIIO-T2 with promising results, and in RIIO-T3 we will continue the work started by WELLNESS and backed by the NIC in their most recent report, with our industry working groups, building on the baseline set by work on flooding resilience.

4.3.5. Preparing for severe weather: Emergency Planning Managers Forum

Emergency Planning Managers' Forum (EPMF) is an ENA led group which focuses on resilience and emergency planning initiatives across GB network operators and the NESO. NGET actively partake in EPMF forums to discuss both steady state and abnormal operating procedures and we have refined our severe weather trigger levels based on EPMF discussions. The EPMF forum shares lessons learnt from significant storm events and works to identify best practice operating models.

We have run feedback sessions with the EPMF to discuss outcomes from severe weather events like Storm Ciaran across our network which focused on the impact of loss of site supplies and building damage / debris.

The EPMF includes escalation and trigger levels for storm events, including the ability to share vulnerabilities or significant impacts. One of the key features of EPMF is to ensure that TO's, DNO's and NESO are aligned in their understanding and processes associated with Emergency Demand Disconnection which may be required during significant storms and asset failures.

The EPMF also coordinates participation in severe weather event responses which are run across industry participants, inclusive of extreme weather.

4.3.6. North East West South Area Consortium

The NEWSAC (North East West South Area Consortium) agreement details the application and co-ordination of mutual aid between network operators in the United Kingdom, Ireland, Isle of Man and Jersey during and after network electricity supply emergencies, for example major storms. Mutual aid includes the transfer of field resources and supplies between network operators in the United Kingdom, Ireland, The Isle of Man and Jersey.

During the RIIO-T2 period, NGET did not make any requests for Mutual Aid via NEWSAC. We have supported Distribution Network Operators through the NEWSAC period, most notably during Storm Arwen. NGET are an active participant to all NEWSAC escalations both in the development of the NEWSAC arrangements and actively participating in all Emergency NEWSAC escalations.

5. Recent Weather Events and Impact to Our Network

Key Points:

- Our inherent network resilience has resulted in low associated costs following storm activity over the last 10 years.
- Lessons learned from these storms have informed our RIIO-T3 business plan investments.
- Coastal erosion has the potential to result in high costs for replacement of network assets. We are confident that our innovation projects will continue to mitigate this risk.
- Rising ambient temperatures and wildfire are an increasingly prevalent risk to the network however, we have demonstrated that we are currently resilient to such risk.

In this section, we set out several case studies of extreme weather events that occurred in the last ten years. These examples demonstrate the historic resilience of our network, the rapid response of our supply chain to large asset replacements, and the ongoing incorporation of lessons learnt into future policies.

Each case study below sets out the relevant climate hazard, the impact to our network, any costs associated (including preparation costs) and the lessons learnt that we have incorporated into future responses to climate related events. We have used examples that relate to each of our highest rated risk hazards, increased severity of storms, high temperatures, coastal erosion, and flooding.

Throughout RIIO-T3, we will continue to model these 'worst-case scenario' events to proactively update our strategy. The development of new digital capabilities and resilience metrics (set out earlier in Section 4 of this document and detailed in Annex A05: Digitalisation Strategy and Action Plan) are key enablers for this.

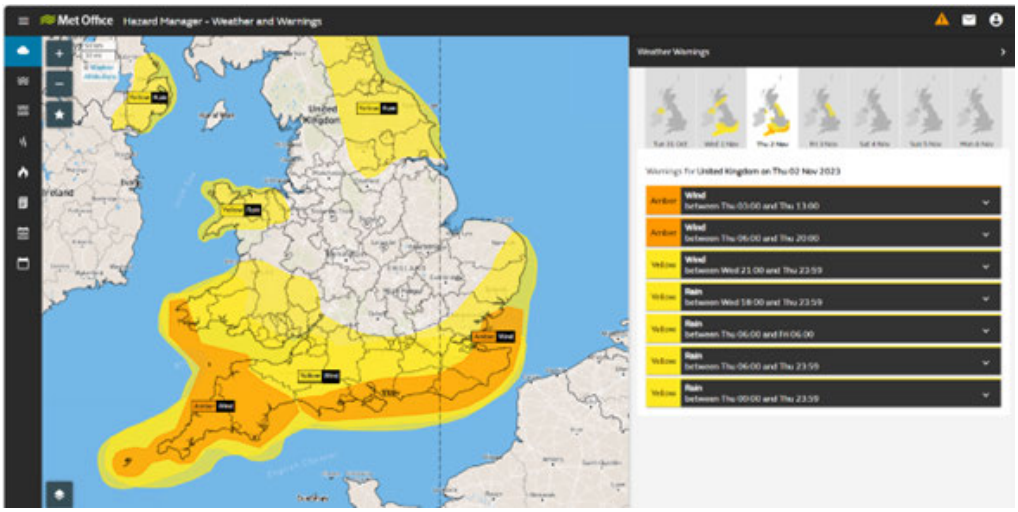
5.1. Storm and Severe Weather Impact Studies

There were eleven named storms over the winter of 2023-24. During each one, our network showed robust levels of resilience to the weather conditions including strong winds and flooding. There was no incentivised loss of supply during this period. This was due to the preparedness of our teams and assets. We have outlined the network and resultant impact of Storms Ciaran and Isha which impacted both the south and north sections of our network respectively. We have selected these events as they were reflective of a compound storm event with high winds, rainfall and lightning activity affecting our network. We also briefly comment on Storm Arwen. Our 2050 and 2100 forecast indicate an increased likelihood of similar events.

5.1.1. Storm Ciaran

The Met Office issued multiple Amber weather warnings for high windspeed for the South East and South West, for Storm Ciaran – in force from 3am, Thursday 2nd November 2023. Wind gust speeds between 70 and 80mph were experienced on the South Coast, creating widespread disruption.

Figure 7: Storm Ciaran Hazard Summary



We prepared as per our Business Continuity Plans:

- Control room resources were strengthened.
- Field team standby rotas were reviewed and found to be sufficient.
- The outage scheduled was reviewed with no significant site-specific risks identified.
- Health checks on site standby generators were completed across all sites.
- Flood defences were reviewed and confirmed in good working order.
- Building conditions were assessed, some cladding concerns identified were monitored.

Impact to our Network:

Although consumers experienced significant impacts from interruptions to DNO supplies of electricity, NGET experienced no significant power outages. Demand was lost to power station supplies at Dungeness due to a non SQSS secured event occurring. The interruption was caused by building debris and increased salt pollution leading to a flashover. This placed the site on temporary standby generation. However, supplies to Dungeness were subsequently restored through Business Continuity Management processes.

During Storm Ciaran there was a 36% increase in alarms received into the control room from 2685 to 3644. Of those, 90 were recorded in our Safe Grid system which provides a record of those alarms requiring a call out or follow up action. Overall, this increase is within tolerance of our severe weather plan and the types of alarms recorded in Safe Grid were within those categories that we would expect during severe weather.

In summary there were:

- 27 'Supply Abnormal' – due to the failure in supply from distribution operators, which we back up with diesel generators
- 12 'Security Alarms' – due to electric fences being hit by debris
- 12 'Trip Alarms' – caused by primary equipment switching out of service, due to the high winds. DARs then restored the equipment automatically as intended.

The below outlines the costs associated with storm preparation and repairs:

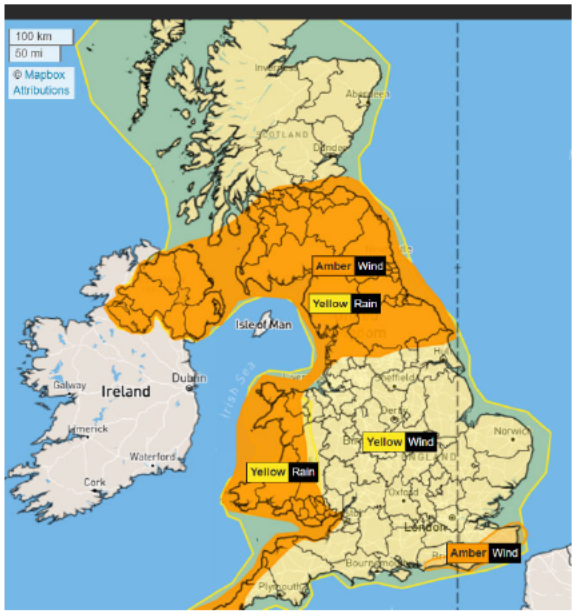
Table 6: Cost Associated with Storm Ciaran

Title	Detail	Cost
OHL Team Patrol - Dungeness-Sellindge circuit	1 Engineer, working for 5hrs	[redacted]
OHL Team Patrol - Ninfield circuit	5 Engineers, working 9hrs each	[redacted]
Security Alarm Call Out	2 Engineers, working for 1hr each	[redacted]
Storm Debris Clearing	Removal of damaged cladding at Dungeness, storm debris and repairs to security fences	[redacted]
Dungeness Substation Building and Transformer Defect Repairs	Repairs to building cladding at Dungeness, Transformer emergency oil sampling, Insulator washing to reduce salt pollution	[redacted]
Alarm Management	3 Additional Control Engineers	[redacted]
Protection Performance Information Fault Reports	Downloading and interrogating Fault Recorder data	[redacted]
Total		[redacted]

5.1.2. Storm Isha

The Met Office issued multiple Amber weather warnings for high windspeed for the whole of the UK, for Storm Isha – in force from 6pm, Sunday 21st January 2024. Wind gust speeds between 70 and 80mph were experienced on the South Coast, creating widespread disruption.

Figure 8: Storm Isha Hazard Summary



We prepared as per our business continuity plans:

- A Bronze Incident Command triggered ensuring that teams had resources in place.
- Control room resources were available during the weekend.
- OHLs were condition assessed to pre-determine post fault recovery strategies.
- Health checks on site standby generators were completed across all sites.
- Increased asset health checks (gas pressures, oil levels etc.) for sites at single circuit risk.

The Impact on Our Network:

Whilst there was no significant spike in alarms, with the pattern following the usual weekly trend, there was a slight increase in emergency calls over the weekend.

Over the storm period 19th, 20th and 21st of January there was a 10% increase in the number of alarms received by the control room but nothing beyond what was expected.

As an example, we had a 29% increase in 'control system abnormal' alarms. The primary reason for this increase was driven by loss of connectivity to the Global Positioning System (GPS). The GPS signalling is used for protection and control devices to provide time synchronisation, necessary for ensuring dependent operations. In 2012, NGET received spurious protection operation due to GPS failures. To avoid the risk of maloperation we now use dedicated fibre networks to synchronise communications for our protection devices, thus mitigating this risk.

We also had an increase in 'transformer abnormal' alarms. This alarm indicates an abnormal operating mode associated with the transformer which does not require urgent rectification but if left may progress to a more critical state.

During storm events, this is often a result of high-water levels in the transformer bunding due to significant rainfall. The other common occurrence during storms is associated with transformer forced cooling systems. At certain substations forced cooling supplies for the transformers are not supported by the onsite back-up generators, this may lead to a downrating of the transformer's capacity. Our design standards have been revised to align with ENA Engineering Recommendation G91 and all future LVAC replacements and new installations ensure that transformer cooling is supported by the onsite back-up generators.

Table 7: Cost Associated with Storm Isha

	Cost
"Manning of sites" Axminster, Mannington, Ironbridge and Rugeley	[redacted]
Total	[redacted]

As a result of the inherent resiliency in the network and required storm preparations, the costs associated with Storm Isha were minimal. NGET chose to staff key strategic network nodes selected through engagement with the NESO. This was to enable increased recovery times in the event of a network fault and minimise the potential for widespread system disturbance.

5.1.3. Storm Arwen

Storm Arwen was a powerful extratropical cyclone that impacted the British Isles on Friday the 26th and Saturday the 27th of November 2021 and caused widespread disruption.

Overall, our network was resilient to Storm Arwen with no losses of supply or enduring network concerns. We recorded 36 network faults across the weekend due to high winds. All faults were managed by the automatic protection DAR (Delayed Auto Reclose), one of our key resilience tools. We had zero faults due to fallen trees confirming good vegetation management. There were a small number of examples of damage from debris to our equipment.

We communicated regularly with key customers before and during the event, attended industry emergency co-ordination calls (NEWSAC meetings), and offered support to Northern Power Grid and Scottish and Southern (North) with overhead line resources and mobile diesel generators.

Given the impact on our network and corresponding actions taken by our teams, there were no significant costs recorded as a result of this event.

5.1.4. How these examples of severe storms have informed our Climate Resilience Strategy

Over the last decade, severe storms have had a relatively low impact on our network. The largest cost was the defect repairs at Dungeness substation which has in turn informed a significant investment into site maintenance for RIIO-T3, ensuring that those buildings at risk of being damaged during a storm are made resilient.

All other recorded costs were attributable to expected outcomes and are mitigated by successful maintenance schemes that we will continue to carry out in RIIO-T3. One such example is our vegetation management which has kept storm debris to a minimum and we have worked hard to make it cost-effective in preparation for RIIO-T3.

Our substations require the provision of a low voltage auxiliary power supply to operate safely and efficiently. This auxiliary supply in many cases is supplied from the local DNO network. During extreme weather events we experience more frequent interruptions to the incoming site supply which effects our critical asset capabilities. During RIIO-T3, we are investing [redacted] on the maintenance and replacement of back up standby generation systems and [redacted] to commission standby generation systems at [redacted] sites that have previously relied on the deployment of mobile temporary generators. These investments will further our strategic objective of **'embed resilience in network design and operations'.**

5.2. Coastal Erosion of Network Tower

On 2nd October 2013 a vertical alignment survey noted that Tower 4ZC30 had had movement of more than 450mm in the Dwyryd estuary, with at least one leg unlikely to be supporting the weight of the tower.

Tower 4ZC30 was built in 1966 and located on salt marsh. Through the action of sea level rise, increased riverine flows during extreme rainfall events, increased storm activity and changes to rainfall patterns on the salt marshes washing through to the estuary, the salt marsh became eroded.

There is also evidence that the installation of groynes on the southern marsh meant a change from growth of the north salt marsh to one of erosion. A shift of the main channel north appears to similarly coincide with the establishment of groynes in the 1960s and 1970s on the south shore to protect a railway located near the tower.

The extent of this erosion meant that remediation was not a viable option, and the tower had to be replaced. There was also clear desire from stakeholders to replace the overhead line with underground cable, given the risks posed. However, it was ultimately determined that the short timelines for implementing a solution meant that this was not viable.

The subsequent response was swift, with relevant stakeholders informed and a 100m exclusion zone established around the tower and adjacent spans. Given the intersectionality of location with other critical national infrastructure, we worked closely with rail and road stakeholders to minimise disruption. In addition, we negotiated the use of site access to the nearby bridge works that removed the need for NGET engineers to establish their own.

The total time taken to implement the recovery plan was [redacted] days, an industry record and a benchmark for future emergency works. The funding mechanism for this work was carried out under the RIIO-T1 steelwork allowance for whole towers which also included the provision for replacement conductors.

Table 8: Summary of Tower 4ZC

CAPEX Costs	[redacted]
Time to Rectify	[redacted]

Figure 9*: 4ZC Images*

5.2.1. How this example of coastal erosion has informed our Climate Resilience Strategy

The emergency demolition and replacement of Tower 4ZC30 has had a significant impact on our climate resilience strategy. It clearly reinforced the need for shoreline management plans to further mitigate the risk that rising seawater levels pose to coastal assets and is now categorised as 'high' in our latest ARP reporting (ET2b).

We have undertaken several assessments to determine which assets are at risk in line with the Environmental Agency's projections. According to those assessments we identified a need to rebuild Fawley substation in a Flood Zone 1 area and will undertake that work during RIIO-T3.

We are also leading an innovation project (ICECREAM) with the aim of gathering detailed, real-time data on the effects of coastal erosion on our towers. Whilst this project will conclude within the timeline of RIIO-T2, the outcome will provide justifications for future investments and allow us to continue to **explore innovative solutions**.

The quick response from our stakeholder network during the inspection, demolition and construction of the tower also demonstrates how integral our collaborative efforts are to the success of any climate resilience initiatives. Going forward into RIIO-T3 we will review new data sets from the British Geological Survey, maintain our links with EPMF and with local authorities.

5.2.2. UK Heatwave Summer 2022

The Met Office issued 'Red' Extreme Heat warnings on Monday 18th and Tuesday 19th July 2022, and in response the UK Government declared a National Emergency, recognising the risk of the heat impacting lives, property and infrastructure. Temperatures passed 40ºC for the first time with several wildfire outbreaks causing extreme stress to the network.

We prepared as per our business continuity plans:
A collaborative incident response with NGESO ensured that overall system resilience was maintained. Engagement with the DNOs through emergency co-ordination calls (NEWSAC) provided visibility of wider local issues impacting consumer's supply. Critical circuits were identified and inspected by our OHL teams to identify any enhanced fire risks.
Risks to operational staff were also recognised. Guidance was therefore provided to staff alongside the delivery of situational risk assessments which were delivered to highlight any additional controls required (timing of activities, hydration and additional rest periods). We assessed OHL thermal ratings against expected ambient temperatures and found low risk associated with the impact.

Impact to our network:

Overall, our network was resilient to the impacts of the extreme temperatures but was put under extreme stress. High ambient temperatures adversely impacted the performance of our supporting air systems, batteries and cooling systems. In particular, the control room building required water hose cooling of condensers on the roof to maintain safe temperatures.

Multiple circuits were switched out of service to protect the safety of firefighters as they managed significant fires, particularly in London. Our network complied with the security and quality of supply standards throughout but this inherently reduced the overall redundancy and boundary capacity of our network with the potential for increased system constraint costs. We also recorded ten fires with impacts to circuits and automated reclose, and three reactors switched out due to heat.

5.2.3. How this example of 2022 extreme heat/BAU 2050 summer temperature has informed our Climate Resilience Strategy

It is important to note that this event was an example of extreme weather in 2022 but will become a commonplace occurrence in the medium to long term (see our ARP 2050 risk matrix). We acknowledge that legacy plant may therefore not be able to cope with increasing temperatures, further stressing aged assets and causing failures. We also recognise the need to be mindful of performance deterioration resulting from "drop-in" refrigerants, where systems get caught up the f-gas phase down.

To that end, we are ensuring that we have upgraded HVAC systems in place which increase the resilience of the network during extended periods of high ambient temperature. During RIIO-T3, we are expanding the availability of air conditioning systems which will benefit the performance of electronic protection and control systems

In addition to network upgrades, examples of extreme heat continue to provide justification for our investment in vegetation management where wildfire could threaten OHLs and our innovation project THERMAL which is modelling the effects of extreme temperature fluctuations on the network.

Finally, we are also in the process of creating a wildfire playbook aligned with NGED and NG Group strategy through our 'Wildfire Committee'. The playbook will supplement our already existing BP118 Business Continuity Procedure and be adopted with the help of our ongoing training exercises. The final goal of this activity is to ensure that our business continuity procedures evolve in line with identified risk to our network.

5.3. Risk Analysis of Extreme Weather Impacts to our Network

Whilst recent historic events have not resulted in significant costs to NGET, we recognise a need to identify potential costs across our network. In RIIO-T2, we undertook an NIA funded project to undertake a probabilistic risk analysis of a section of our transmission network, focusing on intrinsic sources of risk.

Whilst the scope of this project was not focused on climate resilience, we believe the underlying methodology presents a framework to shift from legacy methods of characterising risk qualitatively to quantitative, data-driven methods. These methods include probabilistic risk analysis, convex optimisation, data analysis, and decision analysis. We then looked to determine the individual asset contribution to the overall system risk.

Our analysis was underpinned by our asset health indices data. We strongly support the recent National Infrastructure Committee (NIC) recommendation to develop climate resilience metrics into asset failure probabilities and NARM methodologies to further develop this type of assessment.

Our assessment was broken down into the following key stages:

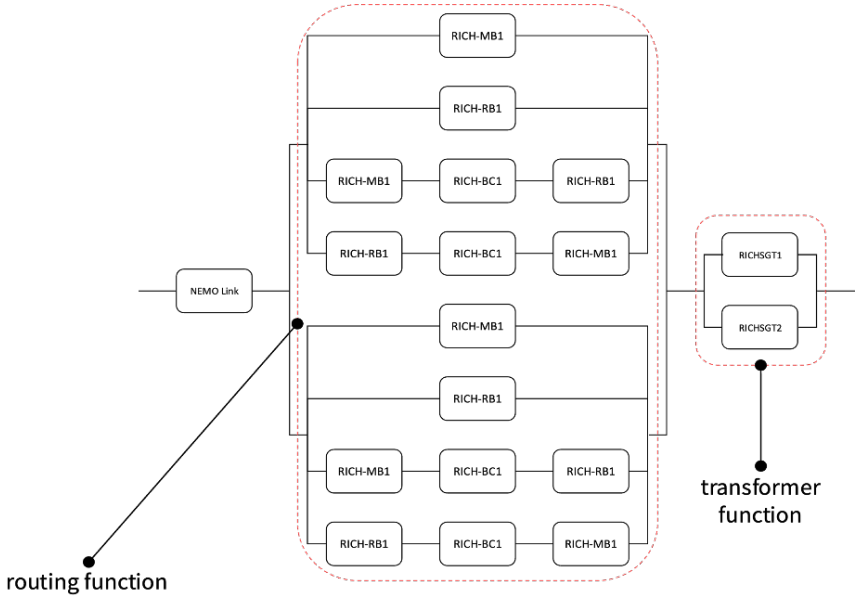
- Determining all the potential system's failure modes.
- Computing probabilities of failure for the system.
- Combining these probabilistic insights with consequence information to determine the overall risk.
- Identifying the "riskiest" assets using importance factor and criticality metrics.

Example Analysis of Potential Risks

We have used an example NGET Substation to reflect the potential cost of failure of the site. The substation is decomposed into 23 assets which includes all primary plant (Circuit Breakers, Transformers, Disconnectors, Busbars).

This site has two primary functions: to route power from a generator and to transform power to lower voltages to support DNO demand. If either the routing function or the transformer function fails, the site is considered in a failed state.

Figure 10: Probabilistic Risk Analysis



The annual probability of failure for this site was calculated to be 0.000312 which means that the likelihood of the site being in a "Failed" state is ~0.03% annually. Our analysis also identified that at this site 98% of all risk is carried by the top 6 most susceptible assets out of 23 assets. It is therefore clear that these assets would be those to target for enhanced resiliency and mitigations against risks.

6. Barriers to Climate Resilience Investment and Mitigation Actions

Key Points:

- We have identified data availability, industry standards, skilled workforce and interdependencies as key barriers to investment in climate resilience.
- We are confident that all these barriers will be mitigated through our partnerships with industry, innovation and ongoing asset upgrades.

6.1. Data & Information Availability

Gaps in climate data impact both adaptation and mitigation strategies. Inadequate data limits the ability of policymakers and organisations to effectively plan and implement climate resilience measures. Because of these data gaps, it's challenging to accurately assess how well adaptation initiatives are being delivered and their relative effectiveness at mitigating the impact of climate change.

There are several areas where improvements can be made:

- **Quality:** existing indicators need to be more reliable and accurate e.g., monitoring towers on coastal sites.
- **Accessibility:** data should be easier to access for those who need it e.g., our Insights Hub.
- **Data-first adaptation strategies:** data should be a key focus for adaptation efforts.

We are mitigating this barrier by focusing on improving quality of our asset data and data-led initiatives through projects like ICECREAM and THERMAL. We are also improving the accessibility of our data through platforms like our Insights Hub and Severe Weather Alerts Tool, enabling decision making for all teams on climate-related assessments.

6.2. Industry-wide metrics and standards

Climate adaptation measures, especially those involving significant upgrades or changes to infrastructure, often require substantial upfront investment. This investment relies on both the ability to quantify the investment and the ability to measure the success of that investment against an agreed standard.

Whilst the particular risk and corresponding required investment in flooding defences has been assured by the standards set out in ETR138, its equivalent does not exist for all climate change hazards. Our innovation projects like WELLNESS and working groups with industry partners take into account this gap, working towards establishing a framework for all risks posed by climate change and driving out a cross-industry agreement on how investment should be placed. This is essential work that will be carried out in RIIO-T3 and is a key dependency for future investment strategies.

6.3. Skilled Workforce Constraints

As climate resilience has become increasingly embedded within the responsibilities of transmission owners, so has the reporting requirements and financial disclosures associated with it.

Capacity to support these requirements, lead innovation projects and develop a strategy to mitigate the increasing risk of climate change requires appropriately skilled personnel.

Our RIIO-T3 Strategic Workforce Plan incorporates an uplift of eight personnel to our Resilience team who will be essential to the success of our initiatives going forward. A proportion of that number will be focused on climate resilience initiatives contained in our RIIO-T3 plan.

As we continue to evolve our understanding of climate change and build further business cases for investment, we will ensure that we expand our workforce appropriately.

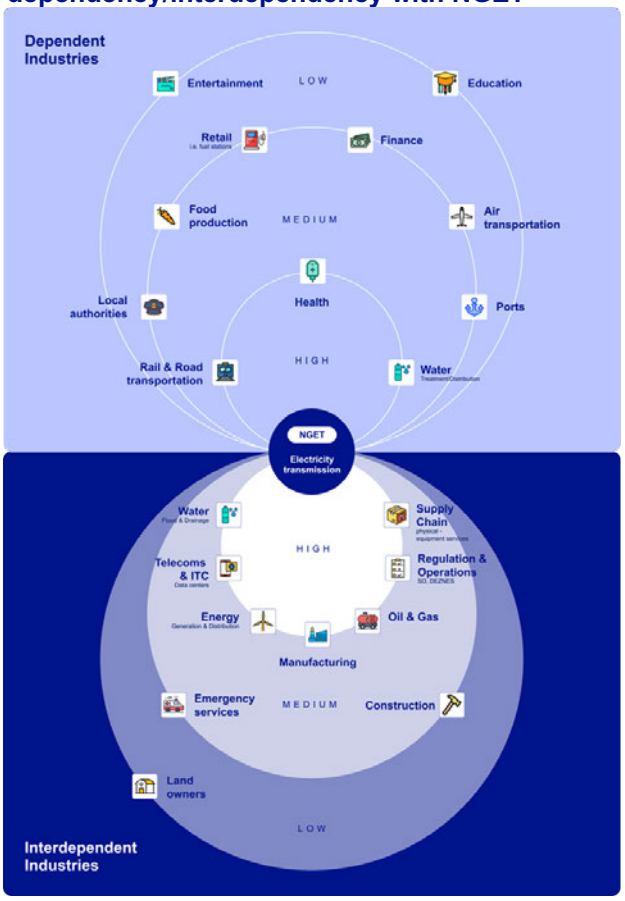
6.4. Interdependencies

Our transmission system is heavily interdependent on other industries and networks. If these networks are not equally resilient or adapted to climate change, this could undermine the effectiveness of National Grid's own adaptation investments, leading to inefficiencies or failures in the broader electricity supply system.

A clear example where differing resilience standards may put a strain on our resilience is battery storage systems. Battery storage must be located within a 500-meter radius of NGET's network. This constraint often necessitates construction in flood-prone areas. While customers installing these batteries may not prioritise long-term impacts, focusing instead on a typical 25-year operational period, NGET must account for these risks. Our aim of ensuring a 1 in 1000 resilience requires us to consider the long-term durability and reliability of these systems, even when our partners may not.

This is why we are committed to ensuring that our innovation projects involve those parties who are required to ensure that implementation of project outcomes are a success.

Figure 11: Industries and the strength of their dependency/interdependency with NGET



We are taking the following actions to mitigate these risks:

- Industry collaboration through innovation projects.
- Maintaining working groups in the lead up to key reporting periods (e.g., ARP).

6.5. Reopeners for climate resilience

Given the challenges of quantifying climate resilience investment, outlined in the above section, it is unlikely that NGET will make use of reopeners during the RIIO-T3 period until work on industry standards can be completed.

Reopeners may be used if an update to a resilience design is required in the short term. However, given the typical development timeline of new design and resilience standards, it is unlikely that a reopener mechanism will be required to fund this work. Rather, we consider it more likely that investment proposals will form part of our next price control business plan as this will allow time to develop with industry and our supply chain.

7. Conclusion

Our latest risk assessment covering RIIO-T3 and beyond remains largely consistent with previous evaluations, with the addition of a profile for 2100.

As we transition to monitoring the effectiveness of our efforts over the last 15 years, we want to reiterate that our commitment to safeguarding our network infrastructure remains unwavering and guided by our strategic objectives:

- Set Smarter Targets for Resilience
- Embed Resilience in Network Design and Operations
- Explore Innovative Solutions
- Support Systemic Adaptation

During the RIIO-T3 period, we will be embarking on a comprehensive programme of upgrades and expansion to our network, driven by the decarbonisation of the energy system and asset health replacement of life expired equipment. These investments will be developed and delivered under the principle of 'resilient by design,' ensuring our infrastructure meets the latest standards to minimise incremental costs and reduce likelihood of retrospective investments in the future.

We are also improving our ability to quantify new climate resilience investments over RIIO-T3 by collecting data on emerging climate risks, such as coastal erosion, through our innovative ICECREAM project.

We are committed to leading the way in setting climate resilience standards across our industry. It is crucial that we get this next period right to accurately estimate the level of investment required for future price control periods.

Recent storm activity has demonstrated the robustness of our network against current risk profiles, and future risk assessments indicate the need for ongoing updates to design standards as our understanding of risks evolves.

The world is facing unprecedented challenges posed by climate change, including once-in-a-lifetime flooding in Spain, record summer temperatures in the UK, and severe storm activity in the USA. These events underscore the importance of our preparation and resilience.

In partnership with the NESO, we are responsible for safeguarding critical infrastructure at the heart of the global shift towards a Net Zero target to mitigate climate change risks. We are prepared to meet this challenge head-on, with the commitments outlined in this document and the support of our industry partners.

Appendix A NGET ARP Risk Scoring

Grouping	Code	Risk	ARP3 Score	ARP4 Score	2050 BAU Score	2100 BAU Score
Business Continuity	ARG18	BCM plans affected due to severe travel difficulties resulting from extreme weather events	1x2	1x2	1x2	1x2
Compound Events	TCFD7	Extreme weather events including a combination of wind, rainfall, temperature or snow	3x3	3x3	3x4	3x4
	TCFD8	Perfect Storm of a cold winter, high electricity demand and heavy persistent rain	3x3	3x3	3x4	3x4
Contaminated Ground	ET4	Polluted ground fires, Old Mine workings	2x2	2x2	2x2	2x2
Erosion	ET2c	Riverbank Stability and Scour	4x3	4x3	4x4	4x4
	ET2d	Groundwater & Geohazards	4x3	4x3	4x4	4x4
	ET2f	Surface Water Runoff Scour	4x3	4x3	4x4	4x4
Fluvial Flooding	AR10	Substations affected by river flooding due to increased winter rainfall	3x3	3x3	4x3	4x3
	ET8a	Fluvial river and coastal flooding of NGET sites	3x3	3x3	4x3	4x3
	ET8b	Fluvial river and coastal flooding – neighbouring sites leaving NGET sites stranded	3x3	3x3	4x3	4x3
	ET8c	Shifting flood areas may affect existing sites in the future	3x3	3x3	4x3	4x3
Ground Movement	AR2	Overhead line structures affected by summer drought and consequent ground movement	3x2	3x2	3x3	3x3
	AR5	Underground cable systems affected by summer drought and consequential ground movement,	2x3	2x3	3x3	3x3
	ET2a	Geohazards	4x3	4x3	4x4	4x4
	ET2e	Landslips, slope stability, ground creep, avalanche	3x3	3x3	4x3	4x3
	MO 4	Repeated Cycles of drought and rainfall	2x3	2x3	3x3	3x3
	TCFD10 b	Increased rate of loss of level in areas with already low depth of cover (e.g., Fenland area)	2x3	2x3	3x3	3x3
Groundwater	ARG22	Groundwater flooding of below ground assets leading to water ingress to pipes	2x2	2x2	2x2	2x2
Interdependencies	ARG17	Supply chain impacts	2x2	2x2	2x2	3x2
	AR13	Substations affected by water flood wave from dam burst	3x3	3x3	3x3	3x3
	ARG13	Vulnerability of critical IT systems managed by third parties from extreme weather events	2x2	2x2	2x2	2x2
	ET8d	Reservoir / Canal Failure	3x3	3x3	3x3	3x3
Lightning	AR14	Overhead lines and transformers affected by increasing lightning activity	2x3	2x3	3x3	3x3
Low Temperatures	ARG6a	Above and below ground assets affected by lower temperatures	2x2	2x2	2x2	2x2
Pluvial Flooding	AR11	Substations affected by pluvial (flash) flooding due to increased rainstorms in Summer and Winter	4x3	4x3	4x3	4x3

Grouping	Code	Risk	ARP3 Score	ARP4 Score	2050 BAU Score	2100 BAU Score
	ARG11	Ground contamination and transport of materials from flooding of contaminated sites	2x2	2x2	3x2	3x2
	MO 1	Increased intensity of short duration rainfall leading to flooding	4x3	4x3	4x3	4x3
Policy & Procedure	ARG1	Lack of climate change management procedure	2x2	2x2	3x2	3x2
	ARG2	Lack of specific policies and procedures governing risk assessment process on climate change	3x2	3x2	3x3	3x3
	ARG3	Risk and action owners not identified at senior leadership team level	2x2	2x2	2x2	2x2
Raised Temperatures	AR1	Overhead line conductors affected by temperature rise.	3x3	3x3	3x4	4x4
	AR4	Underground cable systems affected by increase in ground temperature,	2x3	2x3	3x3	3x3
	AR6	Substation and network earthing systems adversely affected by summer drought conditions	1x3	1x3	2x3	2x3
	AR7	Transformers affected by temperature rise	3x3	3x3	3x4	4x4
	AR8	Transformers affected by urban heat islands and coincident air conditioning demand	3x3	3x3	4x4	4x4
	AR9	Switchgear affected by temperature rise	3x3	3x3	3x4	4x4
	TCFD10	Demand growth in Summer due to increased cooling load	3x3	3x3	4x4	4x4
Sea Level Rise & Coastal Change	AR12	Substations affected by sea flooding due to increased rainstorms and/or tidal surges	3x3	3x3	4x3	4x3
	ARG21	Saline contamination and increased corrosion rate of above and below ground assets from sea water or atmospheric salt	3x2	3x2	3x3	4x3
	ET2b	Coastal Management Policy	3x4	3x4	4x4	4x4
	ET8e	Flooding from Storm Surges	3x4	3x4	4x4	4x4
Snow & Ice	ET7	Snow & Ice; Severity, intensity and frequency of storms	2x2	2x2	2x3	2x3
Solar Weather	MO15	Solar Storm	1x2	1x2	1x2	1x2
Storms	ET6	Severity, Intensity and Frequency of Storms	2x3	2x3	3x3	3x3
	MO11	Temperature / Precipitation: Warm, wetter conditions combined with rainfall and / or wind	3x3	3x3	3x4	3x4
Temperature Cycles	MO14	Diurnal Temperature Range	3x3	3x3	4x3	4x3
	TCFD12	Fast Freeze-thaw cycles	3x3	3x3	4x3	4x3
Vegetation Growth	AR3	Overhead lines affected by interference from vegetation due to prolonged growing season	1x2	1x2	1x2	1x2
Wildfire	AR15	Wildfires	2x2	2x2	2x2	2x3
	ARG16	Wildlife impacts	1x2	1x2	2x2	2x3

Appendix B Acronym Definition Table

Acronym	Definition
AAAC	All Aluminium Alloy Conductor
ACSR	Aluminium Conductor Steel Reinforced
ARP	Adaptation Reporting Power
ASTI	Accelerated Strategic Transmission Investment
BAU	Business as Usual
BGS	British Geological Survey
BIM	Building Information Modelling
BPDT	Business Plan Data Table
CCAS	Climate Change Adaptation Strategy
CCC	Climate Change Committee
CCRT	Climate Change Risk Tool
CNI	Critical National Infrastructure
DAR	Delayed Automatic Reclose
DNO	Distribution Network Operator
EA	Environment Agency
ENA	Energy Networks Association
EPMF	Emergency Planning Managers Forum
ETR	Engineering Technical Report
GPS	Global Positioning System
HTLS	High Temperature Low Sag
HVAC	Heating, Ventilation and Air Conditioning
HVDC	High Voltage Direct Current
IDP	Investment Decision Paper
IFRS	International Financial Reporting Standards Foundation
ISG	Independent Stakeholder Group
ISSB	International Sustainability Standards Board
NAP	National Adaptation Programme
NARM	Network Asset Risk Metric
NESO	National Energy System Operator
NEWSAC	North East South West Area Consortium
NGED	National Grid Energy Distribution
NGET	National Grid Energy Transmission
NIA	Network Innovation Allowance
NIC	National Infrastructure Committee
OHL	Overhead Line

Acronym	Definition
RCP	Representative Concentration Pathway
RRP	Regulatory Reporting Pack
SIF	Strategic innovation Fund
SMP	Shoreline Management Plan
SWAT	Severe Weather Alerts Tool
TCFD	Taskforce for Climate Related Financial Disclosures
TO	Transmission Owner
UKCP18	UK Climate Projection Data 2018

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