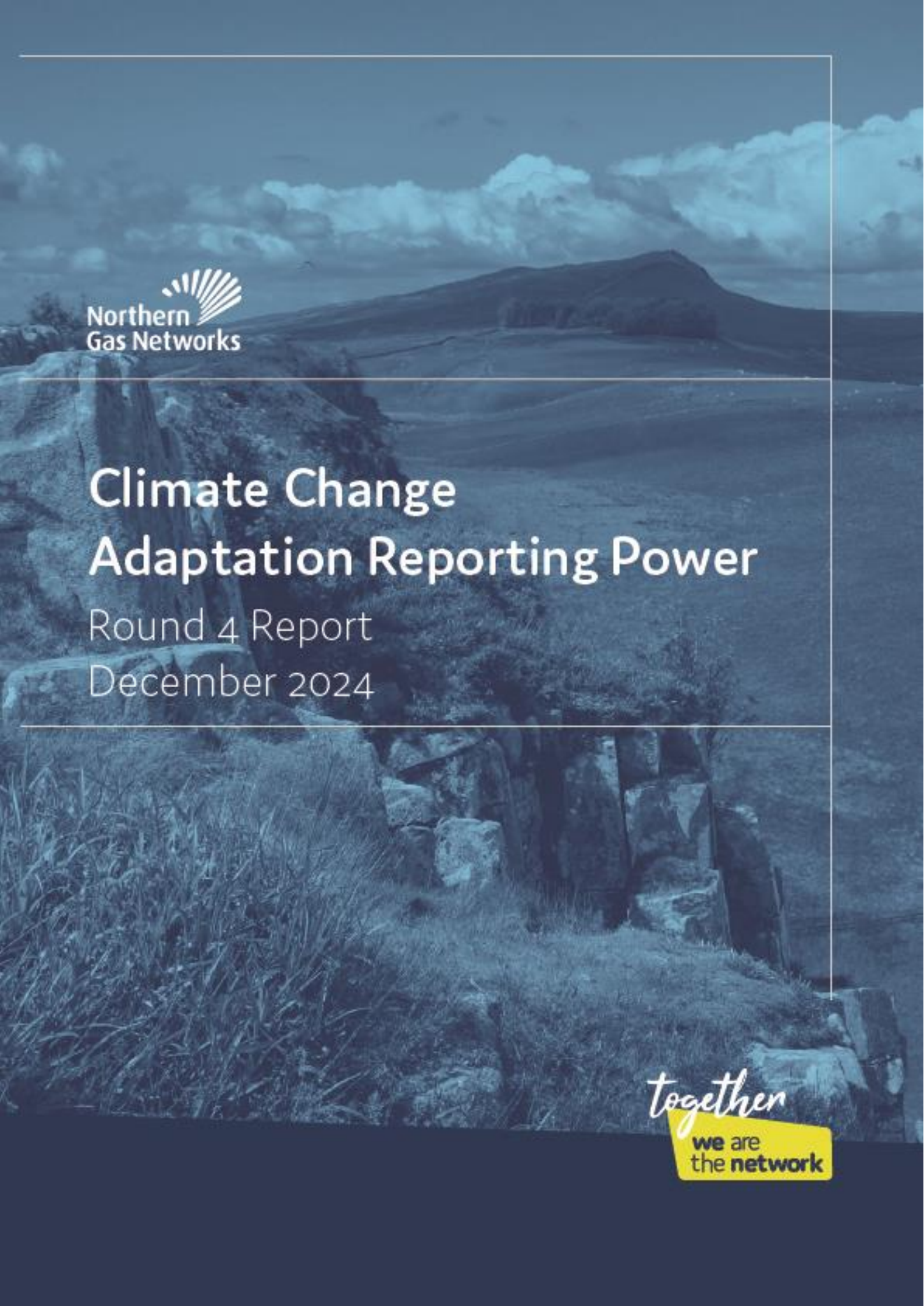

Northern Gas Networks

Climate Change Adaptation Reporting Power

Round 4 Report
December 2024

together
we are the network

Document Structure

This document is structured as follows:

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Report approved by:	Greg Dodd Regulation & Strategic Planning Director Northern Gas Networks
Date:	16/12/2024

Executive summary

Northern Gas Networks (NGN) is the gas distribution network for the north of England. We are responsible for safely delivering gas to approximately 2.9m homes and businesses across northern England. We do not produce or sell gas, rather we transport it via a network of underground pipes which extends for approximately 36,000 km supported by approximately 6,000 strategic above ground infrastructure sites.

We are designated as a reporting authority under the Climate Change Act (2008). NGN have contributed to all rounds of Climate Change Adaptation Reporting Power (CCARP) to date (Round 1 (2011), Round 2 (2015) and Round 3 (2021)).

Progress since previous round

Resilience is a part of the culture of NGN. We lead the industry in maintaining a secure and resilient network because of our commitment to embedding resilience into our business-as-usual activity. Since CCARP Round 3 we have continued to build our resilience by:

- Completing the actions in our CCARP Round 3 Climate Change Adaptation Action Plan.
- Creating a Resilience Framework to integrate all aspects of our business resilience, including with respect to climate change.
- Create a long-term Climate Resilience Strategy covering our next regulatory period (2026-2031) and beyond.
- Learning from extreme weather events and making improvements to our preparedness, regardless of whether our performance has been directly impacted or not.
- Broadening our climate change adaptation risk assessment to include 2°C (RCP 4.5) and 4°C (RCP 8.5) future warming pathways in 2050 and 2100.

Findings

Being located predominantly underground and operating as a sealed and pressurised system, UK gas network infrastructure has proven in the long-term to reliably deliver energy to customers in a dynamic climate. Gas network infrastructure and operations have an overall low to medium risk to climate related hazards currently and into the future, with a lower climate risk profile than electricity infrastructure. No high risks have been identified for any of the time horizons and warming scenarios analysed. The long-term future of gas network infrastructure in the UK is uncertain so our assessment assumes that gas networks will continue to play a critical role in the UK energy system with infrastructure assets and network operation and maintenance requirements similar to current.

Our risk scores for the current time and 2050 are stable between our CCARP Rounds 3 and 4 assessments reflecting our mature awareness of climate change and proactive monitoring and management of assets to mitigate potential impacts. New analysis for CCARP4 identifies that risks in 2100 remain broadly stable across both climate scenarios assessed, albeit with potentially increased likelihoods of occurrence, in particular under a 4°C warming scenario. It is noted that there is relatively low confidence in the 2100 risk ratings due to uncertainties in the climate modelling and long-term gas network characteristics.

Our Climate Resilience Strategy commitments for 2026-2031 include proactive asset management investments to improve resilience, in addition to commitments to regional and national collaboration and development and reporting of climate resilience metrics.

1 Introduction

Northern Gas Networks (NGN) is the gas distribution network (GDN) for the north of England. NGN is designated as a reporting authority under the Climate Change Act (2008).

This report constitutes NGN's response as a reporting authority to the fourth round of the Climate Change Adaptation Reporting Power (CCARP4). The development of this report follows the requirements and guidance set out by the Department for Environment, Food and Rural Affairs (DEFRA) to establish current and future risk against various climate hazards. This report provides an update on our development and progress with respect to climate change risk assessment and mitigation from that provided in our CCARP Round 3 (CCARP3) Report published in 2021. This document should be read in conjunction with our CCARP3 Report which is available here.

As per previous CCARP rounds, NGN has also contributed to the CCARP4 Report provided by the Energy Networks Association (ENA) (available here) of which NGN is a member at the time of publication of this document. NGN and the other gas transmission and distribution networks of Great Britain will leave the ENA on 31 December 2024. The equivalent responsibilities of the ENA with respect to gas networks will be delivered therein by Future Energy Networks which is a company within the Institution of Gas Engineers and Managers (IGEM).

1.1 Introduction to Northern Gas Networks

NGN is responsible for safely delivering gas to approximately 2.9m homes and businesses across northern England. Our network area covers approximately 25,000 km^2 across northern Cumbria, the North East of England and West, East and North Yorkshire, spanning densely populated urban areas and rural areas.

We do not produce or sell gas, rather we transport it via a network of underground pipes which extends for approximately 36,000 km. The operation of our pipe network is supported by approximately 6,000 strategic above ground infrastructure sites.

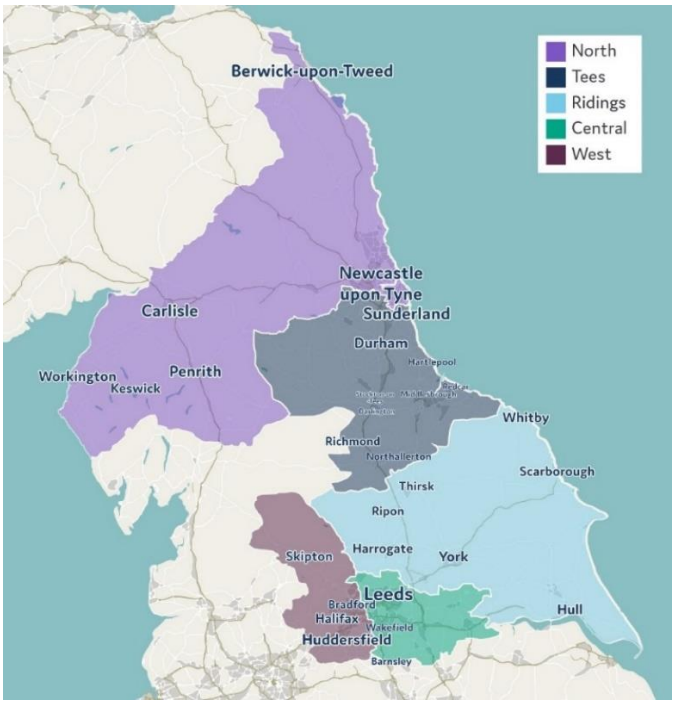

***Figure 1** – Our network area*

Like other gas distribution networks in Great Britain, NGN is a regulated monopoly and operates under a licence issued by the Office of Gas and Electricity Markets (Ofgem) and is also subject to common statutory requirements which are overseen by the Department for Energy Security and Net Zero (DESNZ), the Health and Safety Executive (HSE) and the Environment Agency (EA). Allowed revenues for NGN, including for adaptation to climate change, are currently set by Ofgem in periodic price reviews[1] and require submission of a detailed business plan. Our current business plan covering the period 2021-2026 ('RIIO-GD2') identifies our commitments to ensure we operate a safe, resilient and sustainable network[2], which includes ensuring the resilience of assets to hazards including those posed by climate change[3]. This requirement to present our asset management plans for regulatory scrutiny at frequent, relatively short, intervals demands that we are responsive to our changing climate to ensure that we can satisfy our stakeholders that our network can continue to provide a safe, resilient and sustainable supply of energy to our customers.

Concurrent with the preparation of this CCARP4 Report, NGN are preparing our business plan for the 2026-2031 regulatory period ('RIIO-GD3'). New for RIIO-GD3 is the regulatory requirement from Ofgem to prepare a Climate Resilience Strategy as part of our period business plan. NGN's RIIO-GD3 Climate Resilience Strategy is available here and has been used to inform the preparation of this report.

Under the terms of the Civil Contingencies Act, as a gas network operator NGN is a Category Two responder and as such is required to co-operate and share relevant information with other utilities, the emergency services and local authorities. We are also active participants in the DESNZ Energy Emergencies Executive Committee (E3C), National Emergency Exercise scenario and Gas Task Group emergency scenarios. In addition, given our role as an energy provider we are members of Local Resilience Forums in our region, for example in Northumbria[4] and Cleveland[5]. We support the LRFs in their work to identify potential risks and produce emergency plans to either prevent or mitigate the impact of any incident or catastrophe, including climate-related events, on their local communities.

1.1.2 Climate Change Management within NGN

In accordance with the requirements of the Companies (Strategic Report) (Climate-related Financial Disclosure) Regulations 2022, NGN annually discloses it's approach to the identification, assessment and mitigation of climate change-related issues, including governance arrangements. Our latest disclosure (published in August 2024 covering the 2023/24 financial year) is provided on pages 25-38 here. In recognition of the significance of the wide-ranging potential risks posed to our network infrastructure and operations by climate change, it is included and assessed within in our company risk register. In addition, NGN have reported during all previous CCARP rounds.

Built on this foundation of risk analysis, our understanding of the impacts of climate change to our assets and operations has developed over many years and will continue to evolve into the future. We do not consider climate resilience in isolation, instead we consider climate change resilience as a key pillar of our business-wide Resilience Framework which enables us to embed climate

[1] At the time of preparation of this report, NGN are in the RIIO-GD2 regulatory period which extends from 1 April 2021 to 31 March 2026: https://www.ofgem.gov.uk/energy-policy-and-regulation/policy-and-regulatory-programmes/network-price-controls-2021-2028-riio-2

[2] See Sections 4.3 and 4.4 of our RIIO-GD2 business plan: https://www.northerngasnetworks.co.uk/wp-content/uploads/2019/12/NGN-RIIO-GD2-Business-Plan-2021-2026.pdf

[3] See page 39 of our RIIO-GD2 business plan Environmental Action Plan: https://www.northerngasnetworks.co.uk/wp-content/uploads/2019/12/A8-NGN-RIIO-2-Enviromental-Action-Plan.pdf

[4] https://www.northumberland.gov.uk/About/Partners/Northumbria-Local-Resilience-Group.aspx

[5] https://www.clevelandemergencyplanning.info/cleveland-lrf/

resilience throughout our organisational culture. Our Resilience Framework (as summarised in **Figure 2** below) embeds what we have naturally done for many years to ensure we have an integrated approach to resilience. This approach ensures we can meet whatever demands we might face. For example, the integration of our Network Asset Management Strategy and our Climate Resilience Strategy allows us to identify the risks facing our infrastructure and address them in the most appropriate and efficient way.

Figure 2 *– Our Resilience Framework*

Our Network Asset Management Strategy requires the production of long term (>15 years) asset management plans for each business asset type (for example 'network assets' such as high pressure pipelines, and 'non-network assets' such as company vehicles) to ensure they operate in a safe, resilient, efficient and sustainable manner at the optimum cost for customers. We adopt a risk based approach to asset management to target investment where it is most beneficial with priority given to capital investment over operational interventions to ensure our infrastructure is robust and resilient in the long-term. Individual asset management plans include assessment of relevant material climate change risks (such as flooding or river erosion) and appropriate management measures. The individual asset management plans are used to develop our regulatory investment plans for each asset type which we submit to our regulator for approval as a part of the periodic price control reviews, for example Pressure Reduction Stations[6], Local Transmission System[7] and Overcrossings[8].

[6] https://www.northerngasnetworks.co.uk/wp-content/uploads/2019/12/A23.A-NGN-RIIO-2-Investment-Decision-Pack-Pressure-Reduction-Stations-EJP.pdf
[7] https://www.northerngasnetworks.co.uk/wp-content/uploads/2019/12/A23.C-NGN-RIIO-2-Investment-Decision-Pack-Local-Transmission-System-EJP.pdf
[8] https://www.northerngasnetworks.co.uk/wp-content/uploads/2019/12/A23.G-NGN-RIIO-2-Investment-Decision-Pack-Overcrossings-EJP.pdf

At an operational level, we follow a bespoke Severe Weather Incident Management procedure to provide a framework for deploying necessary people, physical resources and information systems to facilitate operational management and control of an incident due severe weather. A severe weather incident is defined by NGN as any event where operating conditions are such that normal management of workload is unable to maintain our key regulatory standards of customer service (gas emergency 1 and 2 hour response performance) and/or safety targets, and actions are necessary to recover the situation. This procedure has evolved over time and is subject to regular review of adequacy (nominally every two years).

1.2 Gas Distribution Infrastructure

Gas is delivered from the beach terminal via the high pressure National Transmission System (NTS)[9], currently owned and operated by National Gas Transmission plc, to the GDNs such as NGN. Gas is delivered into gas networks' own Local Transmission Systems (LTS) from the NTS at strategic infrastructure sites known as offtakes. Gas at high pressure (>7 bar) in the LTS is moved around the individual GDNs and subsequently reduced to intermediate pressure (2 to 7 bar), medium pressure (75 mbar to 2 bar) and low pressure (<75 mbar) via strategic Pressure Reducing Installations (PRIs – also known as Pressure Reduction Stations (PRS)). Gas is then delivered to domestic and business customers via a network of polyethylene and metallic pipes (mains and services) at low pressure.

NGN operate approximately 36,000 km of underground pipes, of which approximately 1,300km comprises our LTS operated at high pressure. We also operate approximately 6,000 above ground infrastructure sites to enable the operation of our network, including:

23 offtakes where gas is taken from the NTS into our LTS. These sites typically comprise secure gravelled compounds with above and below ground infrastructure covering approximately 0.5 to 2 hectares.	

[9] https://www.nationalgas.com/our-businesses/national-gas-transmission

	
178 Pressure Reduction Stations where we reduce our LTS gas pressure to feed our high, intermediate, medium or low pressure networks. These sites comprise secure gravelled compounds with above and below ground infrastructure covering approximately 0.5 hectares.	 

5,662 governors where gas flow through our network is regulated. These assets are typically above ground and comprise small cabinet to kiosk size assets on plots of land covering c.100 m^2 or less.	A typical district governor (top image) and service governor (lower image)  

Core gas network infrastructure comprises sealed, pressurised, pneumatic mechanical equipment and pipes with supporting digital, electrical and instrumentation equipment. All network infrastructure is designed, installed and maintained to engineering standards established by IGEM to serve agreed customer service requirements. Key customer service requirements that our network must provide include maintaining minimum (21 mb) operating pressures at all network locations and providing a 1-in-20 years measure of peak demand. The 1-in-20 years peak day demand is the level of gas demand that, in a long series of winters, with connected load held at the levels appropriate to the winter in question, would be exceeded in one out of 20 winters, with each winter counted only once.

This report has been prepared to identify and assess the physical climate-related risks to our gas network infrastructure and business operations at the current time (2024) and in the future (2050 and 2100). The role of gas networks in the long-term future of the UK energy system is currently uncertain. As per our CCARP3 report, this CCARP4 assessment of risks in 2050 and 2100 assumes that gas networks will continue to play a critical role in the UK energy system with infrastructure assets and network operation and maintenance requirements similar to those in 2024.

1.3 Previous NGN CCARP Submissions

In association with the ENA and it's other member companies, NGN have contributed to all rounds of CCARP reporting to date (Round 1 (2011), Round 2 (2015) and Round 3 (2021)). A summary of our CCARP Rounds 1 and 2 reports is provided in Sections 1.3.1 and 1.3.2, respectively, in our CCARP3 Report.

1.3.1 CCARP Round 3 Summary

In preparation for CCARP3, the Met Office was commissioned by the ENA, on behalf of its members, to undertake a review of the Met Office UK Climate Projections (UKCP18) data for a worst-case (RCP 8.5) future warming scenario[10]. The purpose of this was to allow networks to better to understand the changes and potential impact to energy infrastructure assets from climate change.

Utilising the Met Office assessment, our CCARP3 response included an assessment of climate change risks in 2021 and 2050 based on UKCP18 for a worst-case (RCP 8.5) future warming scenario. Our assessment identified no high risks and eight medium risks in 2021, with this changing to no high risks and seven medium risks in 2050.

[10] Representative Concentration Pathway (RCP) 8.5, equivalent to approximately +4.3 ºC change in average surface temperature by 2081–2100 compared to average in 1850–1900. Source: Met Office (2018).

2 What risks does extreme weather pose to NGN?

The characteristics and design of our network infrastructure, located underground, sealed and pressurised, and undergoing a long-term replacement programme to durable plastic pipes, provides it with high levels of physical resilience to typical weather conditions. Extreme weather can, however, pose shocks and stresses to our infrastructure and operations.

Consideration of rarely occurring extreme weather events, often referred to as 'high impact, low probability', is important when considering network resilience. These events occur infrequently, but consideration of their magnitude and associated impacts is an important demonstrator of the conditions that networks must be resilient to. Additionally, they provide a real-life stress test of current network resilience.

We identify below how extreme cold and wet conditions can pose significant stresses to gas network infrastructure and operations. Due to the nature and operation of gas network infrastructure (predominantly underground with a small amount of low-rise equipment) extreme heat and/or wind do not typically pose significant threats. As discussed below, gas networks can, however, be indirectly exposed to these hazards due to interconnectivity with other utility networks.

2.1 Extreme cold conditions

Extreme cold weather events exert additional stresses on our network by temporarily significantly increasing demand for gas. For example, during the 'Beast from the East' cold spell in February and March 2018, our region experienced several days of freezing temperatures, heavy snow and strong winds. This resulted in a significant increase in customer gas demand for heating. The design and maintenance standards of our infrastructure provide resilience by resistance and reliability. This meant that our network continued to supply customers with gas throughout this event, including temporarily operating at over 100% of its 1-in-20 peak demand capacity, without failure or associated loss-of-supply events.

It is noteworthy that due to a long-term reduction in customer gas usage, the peak gas demand capacity used for network design historically now comfortably exceeds current peak demand. This therefore provides inherent supply resilience. This level of resilience is maintained by continued investment in asset management to ensure integrity and performance.

A secondary outcome of periods of greater gas demand is that we typically experience increased numbers of reported gas emergencies which we must respond to by dispatching field engineers. During this particular event, we were able to continue to meet our customer service standards, due to being sufficiently prepared, resourced and equipped in accordance with our Severe Weather Management Incident Procedure. As described in more detail in Section 1.1.2, this procedure requires constant refinement and investment to adapt to changing climatic conditions. It enables us to harness learning from each event to ensure that we can continue to deliver for our customers at the optimum level.

2.2 Extreme wet conditions

2.2.1 Flooding

During December 2015 and January 2016, our region was subjected to two extreme weather episodes commonly known as 'Storm Desmond' and the 'Boxing Day Floods'. This resulted in widespread flooding, six events where water entered our gas pipes thereby impacting gas supply to 469 customers' properties (one of which we declared a major incident), and damage to three road

bridges in Yorkshire carrying our pipes. Our emergency response procedures ensured that whilst our pipes were exposed to potential damage during the episodes, our customers continued to be supplied with gas or quickly had their supply restored. The average loss-of- supply duration due to water ingress was 77 hours across the six water ingress events. Responding to the damage to the three bridges carrying our pipes incurred total costs to NGN of £65,000 (in 2015 prices) associated with workforce, materials and equipment (individual incident costs ranged from £7,000 to £40,000).

2.2.2 River erosion

Our LTS provides a critical role in the operation of our network, providing gas storage and bulk transfer from the national system to our lower pressure tiers. The majority of our LTS pipelines were built between 1960 and 1980 and in many instances they cross over and beneath watercourses. Erosion of river banks and beds can threaten the integrity of our pipes by exposing them, leaving them unsupported and/or at risk of being impacted by boulders transported by the river.

Given the criticality of these aged assets and the high cost of replacing them, they are regularly and proactively inspected, receiving targeted engineering remedial works to ensure their integrity and longevity. Over recent years, our inspection programme has identified a small increase in the occurrence of our LTS pipelines becoming exposed in riverbeds and banks due to erosion. This could be related to erosion associated with acute extreme weather events, or chronic long-term changes in hydrological patterns. Where this is identified remedial works are required to ensure the long-term integrity and performance of our pipelines.

An example of one of our recent remedial pipeline projects is provided in **Case Study 1**, along with the associated cost. It is noted that such projects can vary widely in scale and associated cost based on site characteristics and risks, and we have identified the need for a significantly larger project during our next regulatory period (see **Case Study 2**). In the past we would typically expect to complete one such remediation project per year, but over recent years we have seen this increase to two per year.

Case Study 1 – River Bed Erosion Remediation – Black Burn

A routine maintenance inspection of our 450mm diameter high pressure pipeline crossing Black Burn in Cumbria identified that erosion of the riverbed had exposed a section of the pipeline. This was therefore threatening the integrity of the pipe by potentially exposing it to being undermined leaving it unsupported, and/or impacted by boulders transported by the river.

NGN commissioned a specialist geomorphological assessment of the river to identify and assess potential remedial options. Following a site specific multi-element options appraisal, a ramped rock weir was installed over the pipe. This used approximately 100m^3 of local, natural boulders and cobbles during summer 2021 to protect the pipe. This £35k Capex investment was selected as the most sustainable solution as it provided robust protection, minimised impact on river flow and ecology, had limited perceptible visual impact and was low cost.

Case Study 2 – River Bed Erosion Remediation – River Allen

Routine maintenance inspections of our 450mm diameter high-pressure pipeline crossing the River Allen in Cumbria during summer 2023 identified that erosion of the riverbed has exposed sections of the pipeline, with the potential for exposure in the river banks as well. This threatens the integrity of the pipe, and the associated gas supply to over 100,000 customers, by potentially exposing it to being undermined leaving it unsupported, and/or impacted by 1m+ sized boulders transported by the river. Emergency remediation measures were completed during November 2023 to provide temporary protection to the pipeline (rock filled bags) whilst a permanent, durable solution was determined.

During 2023/24 NGN commissioned a specialist site-specific technical assessment of the river to identify and assess potential long-term resilience options. Following a site specific appraisal of 11 potential nature-based and engineering solutions (in isolation and hybrid), pipeline diversion has been determined as the optimum solution to provide long-term (50 years+) resilience and minimised environmental impact. The design works for this solution is anticipated to be completed in our current regulatory period which extends to 2026 (costing £400,000) with engineering works to be completed during our next regulatory period (2026-2031). The total project is anticipated to cost £7.7m (Capex).

2.3 Considering interconnectivities and cascading risks

Interconnectivity between different industry sectors is a source of risk for energy networks, with failures from one sector potentially causing downstream impacts to others. Electricity, telecommunications, road transport and water infrastructure are thought to be the most significant sources of risk.

Much of gas network infrastructure is mechanically operated and can continue to provide its core function of transporting gas in extreme conditions, including under water. Telecommunications are already important for automated and remotely controlled equipment, sharing demand and supply data between distribution and transmission networks, and for communication with personnel in the field. As gas network digitalisation increases and network electrical and instrumentation systems

become more advanced, interconnectivity between the gas, electricity and telecommunications networks also increases, alongside the associated potential for cascading risks.

2.3.1 Interaction with electricity networks

The storms and associated widespread, long-duration electricity outages experienced by our region during the winter of 2021/22 (including 'Storm Arwen' – see **Case Study 3**) has brought this interconnectivity into greater focus. Whilst some of our key gas infrastructure sites experienced network electricity outages during this period, our own backup power provision was able to ensure continuity of gas supply without any related supply interruptions. As detailed in **Case Study 3**, we have since undertaken a targeted capital investment programme, supported by contingency operational investment, to enhance our backup power provision to further ensure that we are resilient to such cascading risks.

Interconnectivity between gas and electricity networks is also important during large loss of gas incidents. This is because customers, in particular vulnerable customers, are typically provided with alternative electrical cooker and heating devices whilst their gas supply is restored. Distribution of this equipment and its use must be monitored carefully and in collaboration with the local electricity distribution network operator (DNO) via our emergency incident communication procedures. This ensures that the local electricity network won't become overloaded, which would exacerbate the impact on customers.

Case Study 3 – Storm Arwen

In November 2021, Storm Arwen brought extreme weather to the UK, with winds reaching up to 98mph in some areas. This brought widespread electricity outages, with over 1 million customers losing power. Approximately 40,000 customers were without electricity for more than three days and nearly 4,000 customers off supply for over a week. An Ofgem report identified recommendations for increasing electricity network resilience, incident handling and customer communications and support.

Large areas of our network, particularly in North East England and Cumbria, experienced significant power outages, which impacted some of our key gas infrastructure sites. Our own backup power provision was able to ensure continuity of gas supply without any related gas supply interruptions throughout. None of our gas infrastructure network infrastructure was subject to significant storm damage.

We have since undertaken a review of our backup electricity supply provision to ensure that we are resilient to such cascading risks. Based on this event, we have identified investments in enhanced backup power provision at key sites which will be implemented across the remainder of our current regulatory period (RIIO-GD2, 2021-2026) and further investments to increase our resilience during our next regulatory period (RIIO-GD3, 2026-2031). Our RIIO-GD2 programme of work includes installing additional or enhanced backup

power provision at more than 20 sites at a cost of more than £2m Capex. Whilst this programme is underway we also hire supplementary standby generators for use at key sites over the winter period at an annual cost of approximately £90,000 Opex.

Following Storm Arwen and the experiences of the electricity distribution networks, we stress tested our website and emergency call-handling system. To ensure that we can manage increased customer contacts during future incidents, we expanded our call-handling capacity to allow us to accept up to 900 calls at any one time. This incident also further highlighted how gas and electricity distribution networks can assist each other during times of emergency to benefit customers.

2.3.2 Interaction with road networks

Road transport is essential for gas networks for attendance at gas emergencies to protect our customers and enable restoration of supply, and to access assets for routine maintenance and emergency restoration. As such, any extreme weather events which impact the road network (such as lying snow and ice or fallen trees due to storms) bring with them potential impacts to our customer service performance.

2.3.3 Interaction with water networks

Water ingress into gas networks results in loss of supply and the requirement for deployment of gas network resources to remove the water and reconnect customers. For example, during March 2023, one such incident in Stanley, County Durham impacted supply to 383 NGN customer properties and resulted in a total interruption duration of 34,200 hours.

Water ingress events are often associated with leaking water mains. This can arise because of ground movement, in particular after cycles of wet and dry weather in certain soil conditions. These water ingress events typically impact older, brittle metallic gas mains. Changing weather patterns could result in increased occurrence of water main leaks, resulting in increased water ingress events in the future. Our emergency procedures must evolve to ensure that we are able to respond to these stresses. However, the occurrence and impact of these events will be mitigated by the continual evolution of our network to more robust plastic pipes.

3 How we serve our customers during extreme weather

3.1 Preparing for extreme weather

We first developed a procedure to manage the impacts of winter weather upon our business operations during 2011. We had failed to meet our Licence obligation for attending and assessing gas escapes during the severe weather of winter 2010/11. This failure resulted in NGN receiving a regulatory financial fine for breach of a licence standard. Our management procedure for this Licence obligation has been continuously refined since, to improve our level of business preparedness for extreme weather and to ensure we always meet our business performance standards.

Around 2015 we observed that our business operations were becoming exposed to impacts from the increasing occurrence of extreme weather outside of the winter season (e.g. summertime flooding incidents). In response, we took the proactive step to evolve our management procedure to become an all-year-round Severe Weather Incident Management Procedure.

We prepare for severe weather in several ways to ensure that we meet our business performance standards regardless of weather conditions. We outline below, the steps that we implement to prepare for severe weather. These steps are aligned to the National Infrastructure Commission's (NIC) principles for resilient infrastructure systems[11] and NGN's Resilience Framework controls:

Anticipate / Reflection:

- Receipt of detailed daily weather forecast data for our individual network sub-regions, including indicators of significant temperature swings.
- Preparation of a daily dashboard of business performance against 14 key performance indicators from our Severe Weather Incident Management Procedure. This highlights potential areas of failure and triggers appropriate responses (e.g. additional resource allocation). To illustrate this, in December 2022, a proactive decision was taken by NGN Senior Management prior to a forecasted cold spell to temporarily cease planned mains replacement work. NGN and contractor resources were diverted to support gas emergencies workload to ensure that we could meet our critical customer service requirements, most notably with regard to gas emergency response performance. This decision was enabled by the proactive changes to contractor terms and conditions driven by NGN as detailed below.

Resist / Resistance:

- Modernising the terms and conditions of employment of our gas engineers and key contractors to provide us with a sufficiently resourced flexible workforce, always able to manage our workload.
- Permanent recruitment of additional gas engineers and training our own staff as emergency reservists. We also train and equip an additional c.30 third-party contractors so they can act as reservist emergency response engineers to supplement our own staff in times of peak demand to ensure that we are adequately resourced.
- Hire of supplementary 4x4 vehicles during winter each year, in addition to fitting all existing fleet vehicles with all-weather tyres, to provide vehicle fleet resilience in winter weather.

[11] https://nic.org.uk/anticipate-react-recover-28-may-2020/

Absorb / Reliability and Redundancy:

- Investment in enhanced and additional backup power provision at more than 20 sites during RIIO-GD2 as described in **Case Study 2**, with further investments to follow in our next regulatory period.
- Stress testing our website and emergency call-handling capability, including increasing our capacity to accept up to 900 calls at any one time.
- Completion of access risk assessments for our priority infrastructure sites.
- Maintenance of vegetation at our infrastructure sites so that access and asset performance are not impacted by storm damage.

Recover / Response and Recovery:

- Investment in innovative new and upgraded water extraction resources for managing water ingress into our pipe network for more effective response.
- Flexibility to re-deploy colleagues and contractors to where they are most needed, with the ability to call on other gas networks for additional support if required.

We produce an annual report of our performance against the requirements of our Severe Weather Incident Management Procedure and review the procedure regularly (typically biennially) to identify potential improvements.

3.1.1 Partnership working

The gas networks of Great Britain have mutual aid agreements in place which enable the sharing of resources (such as gas engineers and customer care officers) when necessary, such as during large loss-of-supply incidents, to ensure customers are restored to gas as quickly as possible. NGN has provided such support to other gas networks in recent years.

Following learnings from Storm Arwen and stakeholder feedback, NGN is currently proactively working with the incumbent electricity DNOs in our region to establish a similar mutual assistance arrangement. This can be called upon in times of need to enable customers to have their energy supply restored as quickly as possible.

NGN has been an active participant in the ENA Climate Change Resilience Working Group since its establishment. This has enabled the sharing of best practice as well as collaborative and consistent reporting of network climate change risks and adaptation actions. Through this group, NGN has also played an active role in the UK government-funded CS-N0W 'Enhancing Resilience in UK Energy Networks' project, which ultimately aims to strengthen the climate resilience of UK infrastructure, housing and communities, with specific focus on energy networks.

3.2 Our long-term performance

To ensure that our network delivers our customer service requirements, we measure and report our performance through a range of common metrics under our RIIO-GD2 regulatory framework. In addition, we monitor our performance internally by a number of bespoke metrics, with the objective of providing class-leading customer service.

In the absence of specific climate resilience metrics, perhaps the most appropriate and effective measure of climate resilience is consideration of customer service performance against key metrics.

We have demonstrated excellent, long-term, resilient customer service performance over the last 10 years spanning a wide range of weather conditions as demonstrated in **Figures 3 and 4**, most notably:

- Attendance at uncontrolled gas escapes within one hour 99.5% of the time or better, compared to a regulatory target of 97%.
- Attendance at uncontrolled gas escapes within two hours 99.6% of the time or better, compared to a regulatory target of 97%.
- 98% of gas escapes repaired within 28 days during RIIO-GD2 to date.
- Consistent, improving performance for number and duration of unplanned gas supply interruptions, regardless of the cause and extreme weather conditions (see **Figures 3 and 4**).
- Average duration of unplanned gas supply interruptions of 5.0 to 5.6 hours, compared to a regulatory target of ten hours during RIIO-GD2 to date.
- Average customer satisfaction rating of 9.59/10 for speed of restoration of unplanned gas interruptions (2023/24).

Our performance from 2021/22 to 2023/24 for the above metrics is provided in our 2023/24 Strategic Commentary report.

Based on the integrity of our assets and our continuously evolving management procedures, we have not been directly significantly impacted by extreme weather in recent years.

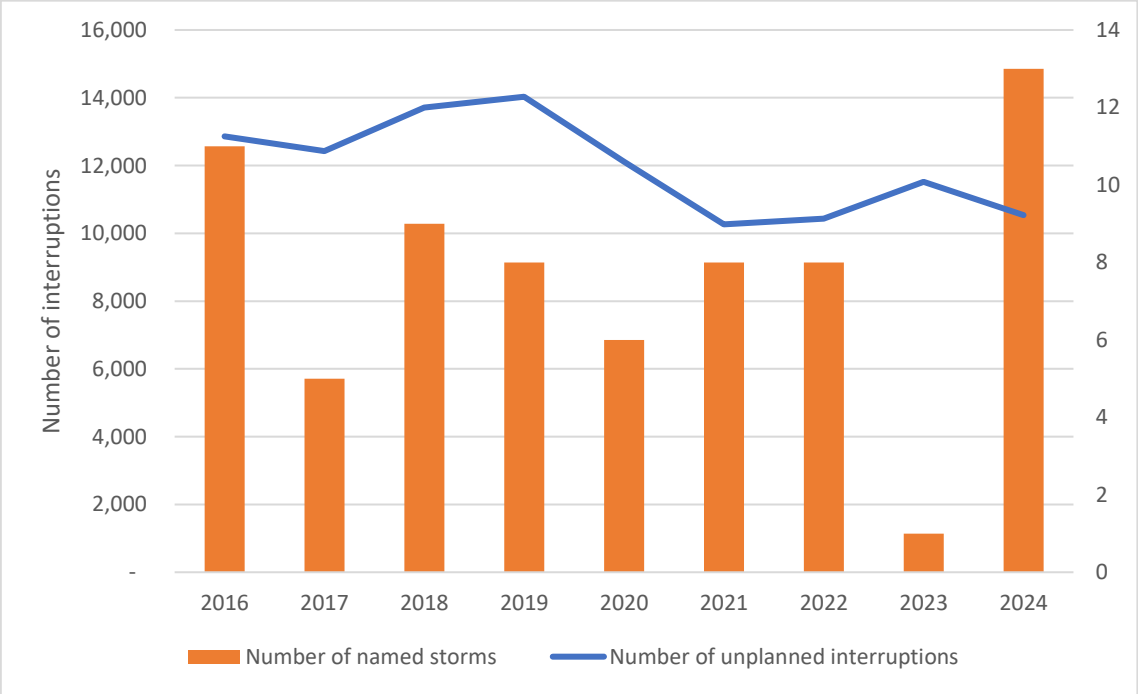

***Figure 3** - Number of NGN unplanned gas interruptions versus number of named storms impacting the UK. Note storms only commenced being named in the UK during 2015/16. Storm data source: UK Storm Centre*

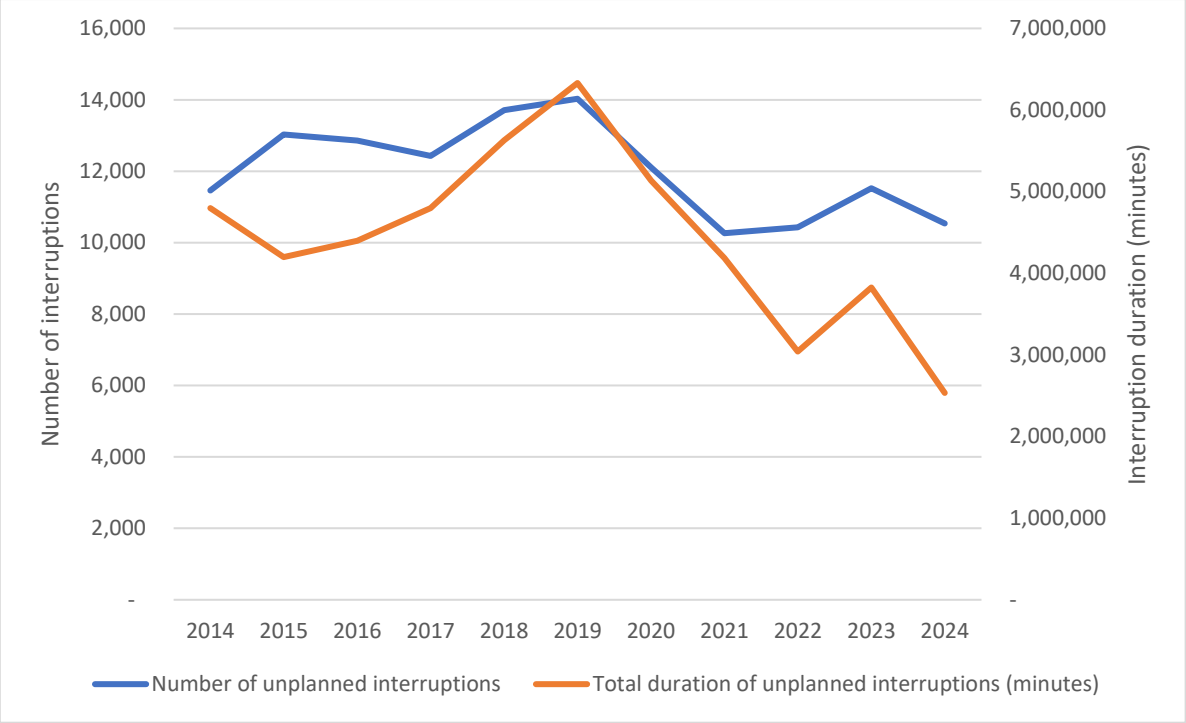

Figure 4 *- Number and duration of NGN unplanned gas interruptions.*

4 Changes since CCARP Round 3

4.1 Continuing to evolve our business preparedness

Resilience is a part of the culture of NGN. We lead the industry in maintaining a secure and resilient network because of our commitment to embedding resilience into our business-as-usual activity. This is demonstrated through our long-term performance against our key customer service metrics as identified in Section 3.2. However, we know that this high performance does not come by chance and is in fact a product of relentless focus and effort. We continuously evolve and refine our Severe Weather Incident Management Procedure to ensure that it is optimised to best serve our customers, notably to manage the risks to our operational performance from extreme cold events. We also continue to adopt a strategic approach to the long-term management of our infrastructure to ensure they continue to deliver a secure and resilience service to our customers.

We learn from extreme weather events that occur to identify areas to further improve our extreme weather resilience. Since preparation of our CCARP3 Report the most significant example of this has been Storm Arwen which impacted our network area in late 2021. As identified in Section 2.3.1 and **Case Study 3**, whilst our network did not incur any outages associated with this event, we have made improvements to increase our resilience including:

- Enhancing our backup power provision at our infrastructure sites.
- Stress testing our website and emergency call-handling system.
- Expanding our emergency call-handling capacity to ensure that we can manage increased customer contacts during future incidents.
- Working to establish mutual assistance agreements with the electricity networks in our region to enable customers to have their energy supply restored as quickly as possible in times of emergency.

During 2024 we have developed a long-term Climate Resilience Strategy for our next regulatory period (2026-2031) and beyond. This strategy builds on our past performance, aligns with our wider Resilience Framework and summarises our key climate risks and what we doing to mitigate them to ensures we are preparing our assets and operations for the climate of the future. Our strategy summarised in Section 6. We consider that climate resilience is most efficiently and effectively delivered with collaboration. Our Climate Resilience Strategy commits us to working with partners and stakeholders to:

- Prepare and respond to extreme weather so that customers, particularly customers in vulnerable situations, get the service they need.
- Develop new climate resilience metrics and indicators and stress testing methodologies.
- Understand blockers to climate resilience investment.

4.2 Enhanced climate scenario analysis

4.2.1 Broader analysis

UKCP18 projections cover four different future climate scenarios known as Representative Concentration Pathways (RCPs) which represent a broad range of potential future climate outcomes as summarised in **Table 1**. The plausibility of the RCP scenarios remains open to debate. Whether any of these scenarios come to fruition, and if so which one, depends on the scale and timescales of global society actions to mitigate climate change, most notably the transition to net zero.

RCP scenario used in UKCP18	Associated indicative societal response to greenhouse gas emissions reduction	Change in average surface temperature (ºC) by 2081–2100 compared to average in 1850–1900
2.6	Strong/high level of emissions reduction	+1.6 (low warming)
4.5	Moderate level of emissions reduction	+2.4 (moderate warming)
6.0	Moderate level of emissions reduction	+2.8 (moderate warming)
8.5	Minimal level of emissions reduction	+4.3 (high warming)

***Table 1** - Summary of future climate change projections for NGN region at mid and end 21st century for 2°C and 4°C warming scenarios. Source: Met Office (2022).*

As described in Section 1.3.1, our CCARP3 submission was informed by bespoke climate change research prepared by the Met Office based on a worst-case (RCP 8.5) future warming scenario. To meet with the CCARP4 requirements, NGN has also reviewed the UKCP18 projections for our region for a moderate future warming scenario (RCP 4.5) to consider an alternative outcome.

Over the course of the 21st century, the UK's climate is expected to typically become more extreme, with hotter, drier summers and warmer, wetter winters, with increased storm occurrences. A summary of the general climatic trends for 2°C (RCP 4.5) and 4°C (RCP 8.5) future warming pathways at 2050 and 2100 for our region is provided in **Table 2**. The data in **Table 2** indicates that our region is already experiencing these climatic trends and that the climate of our region can be expected to experience similar trends to the wider UK. In addition, the data identifies relatively limited differences in climate change projections for the alternative climate change projections by 2050 but much greater divergence by 2100.

Climate variable	Yorkshire and Humber			North East England		
	2010–2029	2040–2059	2080–2099	2010–2029	2040–2059	2080–2099
Mean annual temperature (ºC):						
RCP 4.5	+0.7	+1.3	+2.4	+0.6	+1.1	+2.2
RCP 8.5	+0.8	+1.7	+4.0	+0.7	+1.6	+3.7
Mean winter temperature (ºC):						
RCP 4.5	+0.6	+1.2	+2.0	+0.5	+1.0	+1.9
RCP 8.5	+0.7	+1.6	+3.4	+0.6	+1.4	+3.1
Mean summer temperature (ºC):						
RCP 4.5	+0.9	+1.6	+3.0	+0.8	+1.4	+2.9
RCP 8.5	+1.0	+2.1	+4.9	+0.8	+1.9	+4.7
Mean winter precipitation (%):						
RCP 4.5	+2	+5	+9	+3	+5	+11
RCP 8.5	+2	+7	+15	+3	+7	+17
Mean summer precipitation (%)						
RCP 4.5	-3	-11	-20	0	-7	-18
RCP 8.5	-3	-13	-30	0	-10	-28
50th percentile climate variable difference compared to equivalent for 1981–2000 period for different climate change scenarios						

***Table 2** - Summary of future climate change projections for NGN region at mid and end 21st century for 2°C and 4°C warming scenarios. Source: Met Office (2022).*

4.2.2 Collaborative climate research

Since submission of our CCARP3 report we, alongside other members of the ENA, have played an active role in the UK government-funded CS-N0W 'Enhancing Resilience in UK Energy Networks' project. This project has provided an understanding of the more extreme acute weather conditions

that our region could face by 2080 for a small number of key climatic variables under a worst-case (RCP 8.5) future warming scenario. A summary of the findings for our region is provided in **Table 3** and confirms the broader patterns of our Met Office research as described in Section 2.4.1 of our CCARP3 Report – limited changes in extreme winds, reduced occurrence of extreme cold spells but the chance remains, and wet spells and hot spells becoming more intense and frequent. We have utilised the findings of this project to inform our CCARP4 risk assessment as described in **Section 5**.

Climate hazard	Sensitivity of NGN network to hazard	Pattern of change versus 1980-2000 period	Future approximate return interval of a 1 in 20 years event during 1980 to 2000 period
Windstorms – max wind speed	Low	Minor increase in intensity by 2060–2080	2020–2040: no change 2060–2080: 1 in 14 years
Cold spell – minimum temperature	High	Becomes warmer and less severe. Some uncertainty in signal	2020–2040: >1 in 50 years 2060–2080: >1 in 50 years
Hot spell – maximum temperature	Low	Becomes hotter and more frequent	2020–2040: 1 in 5 years 2060–2080: 1 in 1–2 years
Wet spell – total rainfall	Medium	Becomes wetter and more frequent	2020–2040: 1 in 8 years 2060–2080: 1 in 6 years

***Table 3**: Projected climate hazards for NGN region to 2080 based on RCP 8.5 compared to 1980-2000 conditions. Source: CS-N0W*

4.3 Our CCARP Round 3 Action Plan Progress

Our CCARP3 Report included a Climate Change Adaptation Action Plan for the eight most significant change risks (those that were identified as medium risk in either 2021 or 2050). A summary of our progress against these actions is provided in **Table 4**.

Climate related risk	Possible Gaps	Additional Work Required to Close Gap	Progress update December 2024
CCR21-1 and CCR21-23: Flooding (fluvial, pluvial and tidal) of above ground assets resulting in malfunction and damage	No NGN procedural requirement for review of asset site flood risks. No procedural requirement to assess site flood risk to identify potential requirement for mitigation measures as part of rebuild design process.	Review existing NGN policies and procedures regarding requirements for above ground asset flood risk assessment and protection. Where appropriate update NGN policies and procedures to require periodic reassessment of flood risks to above ground asset sites (eg minimum once every five years) and assessment of flood risk at key asset sites undergoing substantial refurbishment. Ensure consistent NGN requirement for degree of flood risk protection for key asset types.	**Complete** Review of NGN procedures did not identify a procedural requirement to complete flood risk assessment for above ground assets, or a minimum level of flood protection. Allowance for proactive raising of flood sensitive electrical equipment at gas sites located in/near flood risk zones which are scheduled for upgrade included in 2026-2031 investment plans.

Climate related risk	Possible Gaps	Additional Work Required to Close Gap	Progress update December 2024
CCR21-3 and CCR21-25: Damage to exposed and concealed pipe crossings over watercourses as a result of flooding (fluvial, pluvial and tidal).	Risk assessment may change in future dependent on changes to flood risk models, or building/improvement of public flood defences.	Revisit flood risk assessment at regular intervals in asset management planning cycles as current and identify/schedule/undertake mitigation measures as necessary to ensure asset integrity.	**Complete** Risk based pipe crossing remedial works included in 2026-2031 investment plans. Effective assessment of flood risks to gas mains crossing watercourses continues to remain challenging.
CCR21-7: Damage to underground pipes from river erosion (bed and banks), including landslides	Potential for risks to change over time and instantaneously. Effectiveness of management programme to be determined over time.	To be determined dependant on outcomes of management process. Undertake mitigation works as necessary based on outcomes of management process.	**Complete** Allowance for remedial works to gas mains exposed in river banks and beds by erosion included in 2026-2031 investment plan reflective of current increased rates of occurrence.
CCR21-11: Ice and snow events resulting in access difficulties to key assets, offices and depots and operational activities (such as responding to gas emergencies or maintenance activities).	Potential for risks to change over time.	To be determined - procedures subject to continuous review and improvement.	**Complete** Procedures subject to continuous improvement and refinement.
CCR21-18: Underground asset damage because of cycles of dry and wet weather resulting in ground movement.	Lack of detailed understanding of relationship between soil type, weather conditions and potential for ground movement and resultant impacts on asset condition.	Continuous review of asset failure records against outcomes of 2016 study to look for correlation / indicators. Collaboration with industry peers to share best practice	**Complete** Gas leakage data reviewed against soil condition data and no apparent correlation identified. No opportunity arisen.
CCR21-22: Asset damage from increased occurrence from wildfire	Potential lack of appreciation of risk in company procedures and risk assessments	Recommend inclusion in asset risk registers. Review NGN above ground infrastructure site vegetation management procedures with respect to potential wildfire risks. Amend as necessary.	**Complete** Now included in NGN risk register. Procedures reviewed and determined to be sufficient.

***Table 4**: Progress summary against NGN CCARP3 Climate Change Adaptation Action Plan at December 2024.*

5 CCARP Round 4 Risk Assessment

Consistent with our responses to CCARP 1, 2 and 3, we have produced a semi-quantitative risk assessment for this CCARP4 Report to assess current risk ratings (in 2024) and in 2050 for the 34 individual climate change risks included in our CCARP3 risk assessment. New for CCARP4, our risk assessment also includes assessment of risks in 2100, in addition to confidence ratings for our 2050 and 2100 assessments. Given the similar climate signals in 2050 for the 2°C (RCP 4.5) and 4°C (RCP 8.5) future warming pathways (as discussed in Section 4.2.1), a combined risk rating is provided for these for 2050, with separate risk ratings for 2100 to reflect divergence in the climate signals.

It is of note that future climate projections rely on assumptions and reduce in accuracy the further into the future the prediction is made. All scoring for 2050 and 2100 is subject to unseeable variables and this is reflected in the confidence rating. In general, current climate projections for 2050-2070 have reasonable confidence, however beyond 2070 confidence decreases significantly.

Our CCARP4 risk assessment is based on the following assumptions:

- Climate risks will continue to be mitigated to current levels by continuation of business-as-usual proactive asset management.
- The climate information and predictions set out in UKCP18, the Met Office Report provided for the energy industry as used in our CCARP3 Report and information provided by the CS-N0W project.
- In 2050 and 2100 gas networks will continue to play a critical role in the UK energy system with infrastructure assets and network operation and maintenance requirements like those in 2024, and our asset management procedures remain the same as current.
- Our risk assessment reflects broad network wide assessment of impact. Local impacts on an individual asset scale may be more significantly impacted but with a relatively low overall impact to NGN network operation.

Our CCARP4 risk assessment has been produced using the same methodology as our CCARP3 risk assessment which is aligned with the NGN corporate risk management framework and that used in the collaborative CCARP4 submission by the ENA. The risk assessment framework used in this CCARP4 Report is provided in **Appendix A**.

5.1 Risk Assessment Findings

Our CCARP4 risk assessment is provided in **Appendix B**. In addition to individual risk and confidence ratings, **Appendix B** identifies the potential impact of each risk on NGN, the current mitigation measures in place, and commentary regarding material changes between CCARP3 and CCARP4.

Being located predominantly underground and operating as a sealed and pressurised system, UK gas network infrastructure has proven in the long-term to reliably deliver energy to customers in a dynamic climate. Gas network infrastructure and operations have an overall low to medium risk to climate related hazards currently and into the future, with a lower climate risk profile than electricity infrastructure.

Table 5 summarises the findings of our CCARP4 risk assessment and identifies how our CCARP4 current and 2050 risks differ compared to our CCARP3 assessment. Our risk scores are stable between CCARP3 and CCARP4 reflecting a mature awareness of climate change and proactive monitoring and management of assets to mitigate potential impacts.

In keeping with our CCARP3 assessment, our CCARP4 assessment did not identify high risks for any of the time horizons analysed for either the 2°C or worst-case 4°C warming scenario. Our CCARP4 assessment identified seven medium risks currently and in 2050, in keeping with our CCARP3 findings.

Time horizon	Risk Ratings Identified in CCARP4 assessment compared to CCARP3 assessment			
	Negligible	Low	Medium	High
Current (2024)	11 (no change)	16 (+1)	7 (-1)	0 (no change)
2050 (2°C and 4°C)	9 (-1)	18 (+1)	7 (no change)	0 (no change)
2100 (2°C)	8 (n/a)	20 (n/a)	6 (n/a)	0 (n/a)
2100 (4°C)	4 (n/a)	22 (n/a)	8 (n/a)	0 (n/a)

***Table 5**: Summary of CCARP4 risk ratings compared to CCARP3 ratings (where applicable).*

Table 6 summarises the most significant climate risks facing NGN currently, in 2050 and in 2100. The overall risks posed to our network from the following climatic-derived sources of damage to our assets, and associated potential for supply loss incidents, are expected to remain similar in 2050 compared to current:

- Flooding of above-ground assets (CCR21-1 and CCRR21-23)
- Flood damage to pipes crossing watercourses (CCCR21-3 and CCR21-25);
- Damage to underground pipes from river erosion (bed and banks), including land slippage (CCR21-7).

This assessment is based on consideration of the physical aspects and integrity of our assets, and the strength of our asset management procedures.

The risk posed to our above-ground assets from wildfire related damage (CCR21-22) is expected to increase by 2050 as the likelihood of extreme heat events increases. It is noted however that this is an emerging risk and our understanding is relatively nascent.

The overall risk associated with significant ice and snow events impacting the management and operation of our network (CCR21-11) is expected to remain as current by 2050, but with a lower likelihood of occurrence. This is because whilst temperatures will generally increase, there remains the potential for extreme cold spells. In addition, the risk of underground asset damage because of cycles of dry and wet weather, or frost heave (during extreme cold weather), resulting in ground movement (CCR21-18), is expected to reduce from medium to low risk by 2050. This is as a result of completion of our long-term programme of replacing aged, brittle metallic gas mains with more durable, flexible plastic pipes.

Cascading risks due to interconnectivities between energy and telecommunications networks (CCR21-32 and CCR21-33) are expected to remain as current in 2050 as this risk is already recognised and managed (such as by the provision of standby generators). It is recognised, however, that high impact-low probability events such as Storm Arwen could occur more frequently in future and their implications could become more complex as utility network integration becomes more advanced.

Beyond 2050, the overall risks from the identified climate hazards remain broadly stable across both climate scenarios assessed, albeit with potentially increased likelihoods of occurrence, in particular

under a 4°C warming scenario. Of particular note, the risk of significant ice and snow events impacting the management and operation of our network (CCR21-11) is expected to reduce to low by 2100 under both scenarios, however the potential for such events to occur will remain. It is noted that there is relatively low confidence in the 2100 risk ratings due to uncertainties associated with climate projections for that time horizon and how they would impact network infrastructure.

Climate risk	Current risk rating	2050		2100		
		Risk rating 2ºC and 4ºC	Confidence	Risk rating 2ºC	Risk rating 4ºC	Confidence
CCR21-11: Extreme cold spells impacting transport and operational response performance	Medium	Medium	Medium	Low	Low	Medium
CCR21-1 and CCRR21-23: Flood damage to above-ground assets	Medium	Medium	Medium	Medium	Medium	Low
CCCR21-3 and CCR21-25: Flood damage to pipes crossing over watercourses	Medium	Medium	Medium	Medium	Medium	Low
CCR21-7: Damage to underground pipes from river erosion and land slippage	Medium	Medium	Medium	Medium	Medium	Low
CCR21-22: Above-ground asset damage from wildfire	Low	Medium	Low	Medium	Medium	Low
CCR21-18: underground pipe damage by ground movement	Medium	Low	Medium	Low	Low	Low
CCR21-32 and CCR21-33: cascading risks due to interconnectivities between energy and telecommunications networks,	Low	Low	Medium	Low	Medium	Low

***Table 6**: Principal NGN climate related risks currently and in 2050 and 2100 for different future warming scenarios assuming continuation of current levels of mitigation and management.*

5.2 Outlook

Looking to the future the following are identified as evolving/emerging risks which require continued monitoring and evaluation in future CCARP assessments:

- **The long-term future of gas networks**: whilst gas networks currently have high levels of resilience due to the nature of their assets, this resilience may change as the nature of the networks evolves in the pursuit of net zero targets. For example, future partial or sequential decommissioning of gas networks would create more single-feed sub-networks. These would have lower supply continuity resilience than currently and may need reinforcement investment to retain supply resilience at current levels. This necessary investment would be spread over a smaller customer population potentially increasing affordability issues. Alternatively, if such investment did not materialise, it poses the risk of leaving gas customers, some of whom will include those who cannot switch from gas due to cost issues or their local electricity network configuration, with reduced levels of energy supply resilience and therefore facing greater levels of vulnerability.
- **Interdependencies**:
    - *Energy networks*: Energy systems can be seen as a cohort of systems, each reliant on another's outputs to operate and therefore being susceptible to climate change impacts within the wider system. This is analogous to a chain only being as strong as its weakest link. The UK's energy system will become increasingly integrated as whole-system solutions are sought to deliver the UK's net zero commitments by 2050. As such, climate change related vulnerabilities within the wider energy system need to be fully understood when assessing individual network risks.
    - *Telecoms networks*: Critical energy system control communications are based on a resilient SCADA system, however, there is still an operational reliance on public telecommunication networks for communicating with field staff and remote assets. Loss of public communications network connection, such as from loss of mobile mast electricity supply or physical damage (such as storm damage), can impact energy network operational performance.
    - *Non-utility networks*: Energy networks, in particular gas networks, are reliant on dispatching field engineers to attend to gas emergencies and resolve network issues. The resilience of our operational performance has a strong interconnectivity with the operability of UK road networks which can become compromised by extreme weather events, such as flooding, snow and ice and fallen trees during windstorms.
- **Windstorms:** Gas network infrastructure is principally located underground with a relatively small amount of low-rise above ground equipment and as such wind is currently assessed to pose no direct significant risks to gas infrastructure. There is no clear signal in the future climate projections of increasing occurrence of extreme wind events in NGN's region, however, recent experience suggests this may be the case. This will need to be monitored into the future as the occurrence and intensity of windstorms becomes better understood and the nature of future gas network infrastructure becomes clearer.
- **Increased humidity:** This is identified as a potential future risk to gas systems with the potential to cause increased metallic asset corrosion and water ingress. This is not currently sufficiently understood to include in our risk assessment but should be monitored into the future.

6 Our Climate Change Resilience Strategy

During 2024 we have developed a Climate Resilience Strategy. This strategy identifies our approach to managing physical climate change-related risks to our network during the period 2026-2031 and beyond to ensure we can continue to provide our customers with a safe and resilient energy supply.

6.1 Considerations

Our customers consistently rank providing a reliable gas supply in their top two priorities for NGN, second only to keeping bills low[12]. They tell us that resilience means their gas supply is available to use whenever they need it, whatever the present and future weather conditions.

Investments in climate resilience must be viewed as a trade-off between increased costs to customers now from proactive investment, versus delaying investment, which may impact customer service performance in the future and incur greater costs to future billpayers.

Our customers have told us they prefer NGN to adopt a cautious approach to climate resilience investments to ensure we continue to be resilient in the future whilst minimising costs to customers now. This is contrasted by the views of expert stakeholders who identified a desire for us to invest more proactively in climate resilience to increase our readiness for the future.

Consideration must also be given to:

- Uncertainties regarding the accuracy of climate change projections.
- The trajectory of global action to tackle greenhouse gas emissions.
- The long-term future of gas network infrastructure compared to risks that might become apparent post-2050.

6.2 Our Climate Resilience Strategy for 2026-2031

6.2.1 Resilience investments

Our Climate Resilience Strategy includes actions to be delivered during 2026-2031 to increase resilience to our identified principal climate risks (as identified in **Table 6**). These actions will enable us to continue to provide our customers with the levels of service they currently receive, or better, in a changing climate.

We will continue to evolve and refine our Severe Weather Incident Management Procedure to ensure it is optimised to best serve our customers, notably to manage the risks to our operational performance from extreme cold events (CCR21-11), but also extreme wet events (CCR21-6). In addition, **Table 7** identifies investments that we will make as part of our wider operational and asset management investment plans during the period which will mitigate our principal climate related risks.

This programme of work is scoped to be necessary, cost efficient and targeted to address known specific risks. It is also forward looking and flexible to enable us to respond to anticipated risks based on recent experiences and future projections.

As detailed in **Section 5**, there is limited difference in the climate risks to NGN for either the 2°C or 4°C warming scenarios, in particular at 2050. It is therefore difficult at this stage to identify different investment plans to prepare for either scenario and a precautionary approach of preparing for the

[12] See pages 15 and 18: https://together.northerngasnetworks.co.uk/wp-content/uploads/2024/03/Customer-Perceptions-2024-Wave-4.pdf

worst-case is considered prudent in the face of uncertainty. As the climate science and understanding of the implications for energy networks advances, we will work with stakeholders to explore the scope and cost differential of resilience investments necessary to prepare for the different scenarios.

Climate risk	NIC resilience principle / NGN resilience control	Strategic investment details and investment category
CCR21-11 and CCR21-6: Extreme cold and wet spells impacting transport and operational response performance	Anticipate and Absorb / Resistance	Continual review and refinement of severe weather management procedures and preparations.
CCR21-1 and CCRR21-23: Flood damage to above-ground assets	Resist / Resistance	Flood mitigation by proactive raising of electrical equipment at 14 critical sites located in/near flood zones as part of wider site condition upgrade works.
CCCR21-3 and CCR21-25: Flood damage to pipes crossing over watercourses	Resist / Resistance	Overcrossing inspection and remedial programme: proactive condition inspection programme for pipes crossing watercourses ('overcrossings') with targeted bespoke remedial measures to ensure integrity.
CCR21-7: Damage to underground pipes from river erosion and land slippage	Resist / Resistance	Pipeline integrity management programme: proactive pipeline condition inspection programme with targeted bespoke remedial measures such as armouring (low cost) or diversion (high cost) to ensure integrity based on recent experience of occurrences. See **Case Study 3** for an example investment.
CCR21-22: Above-ground asset damage from wildfire	Resist / Resistance	Asset maintenance programme: proactive maintenance of site vegetation across NGN's portfolio of gas infrastructure sites and gas pipeline easements.
CCR21-18: underground pipe damage by ground movement	Resist / Resistance	Iron mains replacement programme: continuation of 30-year programme (2002-2032) of replacing aged metallic pipes with durable plastic alternatives.
CCR21-32 and CCR21-33: cascading risks due to interconnectivities between energy and telecommunications networks,	Absorb / Reliability	Installation of enhanced standby power provision (battery systems or generators) at 26 critical gas infrastructure sites as part of site condition upgrade works. Newly installed generators will have enhanced fuel storage capacity and telemetry systems to remote enable monitoring of fuel levels where practicable and appropriate.
All risks: Mutual assistance agreements with DNOs	Recover / Response and Recovery	Establishment of mutual assistance agreements with the electricity network operators in our region to enable customers to have their energy supply restored as quickly as possible in times of emergency. This is captured in our new voluntary commitment for 2026-2031 to establish a Mutual Support Framework with electricity networks in our region to support customers during energy supply incidents.

***Table 7**: Climate resilience investments for 2026-2031.*

6.2.2 Commitment to collaboration

NGN has been an active participant in the ENA Climate Change Resilience Working Group since its inception. We will continue to work collaboratively with our energy network partners and other stakeholders throughout RIIO-3. This will enable:

- The sharing of knowledge and best practice.
- The standardisation of reporting.
- Input into the development of climate resilience metrics/indicators. Stakeholders have identified to Ofgem that the development of climate resilience metrics and indicators for energy networks would offer potential benefits. These would include use of these indicators in stakeholder communication, cost benefit analyses, and reporting the benefits of actions taken. We will continue to actively collaborate with our stakeholders and partners with the aspiration to begin monitoring and reporting during our 2026-2031 regulatory period.

These efforts will continue irrespective of the departure of the gas networks from the ENA in 2024. Gas networks will continue to collaborate on climate resilience via membership of the Future Energy Networks.

We will also continue to actively participate in climate resilience focus groups in our region to encourage local collaboration, data sharing and partnership working to benefit our customers and stakeholders. Our engagement with utility network partners in our region during 2024 identified multiple areas where we can work together to build resilience.

6.2.3 Commitment to reporting

We will continue to submit CCARP reports in future rounds. In the interim, we propose to also report performance against our Climate Resilience Strategy commitments in our Annual Regulatory Report. We will summarise further key advancements in our Annual Environmental Report (such as advancement with the development of climate resilience metrics/indicators). Reporting could also include 'leading' indicators of climate change resilience actions, such as risk assessments completed, or proactive mitigation works completed. This would provide stakeholders with an understanding of the actions being taken to build resilience.

Appendix A – Climate Change Risk Assessment Framework

This CCARP Round 4 risk assessment has been produced using a methodology aligned with the NGN corporate risk management framework and that used in the collaborative CCARP4 submission by the ENA and our CCARP3 Report. The risk assessment methodology is based on the definition and assessment of both the level of impact (see Table A1) and likelihood (see Table A2) of the identified risks being realised. The potential impact and likelihood of occurrence of each individual risk are scored and multiplied to provide an individual risk score and overall comparative risk rating using Table A3.

Rating	Definition
Extreme/Catastrophic	Regional area affected with people off supply or significant asset failure which exceeds ability for network intervention or reinforcement. Financial: Cost impact >£50M, typically >£20M Safety: Multiple fatality/HSE Enforcement Notice Reputation: External impact on international stakeholders, company accused of poor practice or negligence, direct blame to company leading to extensive media coverage, significant business and company value impact, loss of licence Environment: Reportable incident, serious and lasting environmental damage or loss (>10 years recovery), enforcement action and fine certain Asset/Security of Supply: Total loss of asset, major conurbation and high customer numbers off supply for lengthy period of time (major conurbation off supply >24 hours), national transmission system disruption
Significant/Major	County or city area affected with people off supply or significant asset failure which requires significant network intervention or reinforcement. Financial: Cost impact ≤ £50M, typically £10-20M Safety: Fatality/Life changing injury/HSE Enforcement Notice Reputation: External impact on national stakeholders, extensive media coverage, business and company value impact, repeated regulatory intervention, potential loss of licence Environment: Reportable incident, significant environmental damage or loss (5-10 year recovery), enforcement action expected Asset/Security of Supply: Significant asset damage or failure, geographical area off supply, major outage on distribution networks
Moderate	Significant increase in costs of response and network strengthening Financial: Cost impact ≤ £30M, typically £1-10M Safety: Major injury e.g. RIDDOR reportable Reputation: External impact on stakeholders, adverse media coverage, negative customer impact, regulatory intervention, minor company value impact Environment: Reportable environmental incident resulting from breach of consent or permit, medium damage and loss to environment (up to 5 years recovery), potential enforcement action/letter of concern Asset/Security of Supply: Asset damage of failure, significant numbers of tariff customers off supply for considerable time
Minor	Cost of network maintenance requirements and impact on business now of concern Financial: Cost impact ≤ £10M, typically £500K - £1M

	Safety: Lost time injury/HSE Letter of Concern Reputation: Internal impact within business and stakeholders, industry press and local media interest supported by regulator, some business criticism Environment: Minor, potentially reportable incident affecting local environment (< one year), quick resolution Asset/Security of Supply issues: Minor asset damage or failure leading to localised loss of supply for a short period of time, firm contract customer supply affected
Minimal	Limited impact - can be managed within "business as usual" processes Financial: Cost impact ≤ £5M, typically < £500K Safety: Minor injury/medical treatment/near miss/negligible Reputation: Internal issue from local event, negligible inconvenience, minimal local media coverage Environment: Non-reportable incident with negligible environmental impact or damage, immediately resolved Asset/Security of Supply: Limited impact on assets and supplies, limited disruption to interruptible supplies

Table A1 – Climate change impact definitions

Rating	definition
Almost certain	The risk is expected to be realised and may already be under active management as an event. No controls in place to reduce likelihood of risk being realised. Guideline: >90% or at least once a year frequency.
Likely	More likely and probably will occur, mitigations not fully effective, control weaknesses are known but being managed. Guideline: 60-90% or 1 in 5 years frequency.
Possible	Equally likely as unlikely, mitigations are in place, control measures are under active management. Guideline: 30-60% or 1 in 10 years frequency.
Unlikely	Events are rare and unlikely but could occur, required mitigations in place, controls are effective. Guideline: 10-30% or 1 in 15 years frequency.
Very Unlikely	No known event or extremely rare or remote chance of occurring, controls are fully effective to reduce likelihood of risk being realised. Guideline: <10% or 1 in 20 years or greater frequency.

Table A2 – Frequency of occurrence definitions

Horizons: 2021 and 2050		Likelihood				
Consequence		Very unlikely	Unlikely	Possible	Likely	Almost Certain
		1	2	3	4	5
Extreme/Catastrophic	5	5	10	15	20	25
		Low	Medium	High	High	High
Significant/Major	4	4	8	12	16	20
		Low	Medium	High	High	High
Moderate	3	3	6	9	12	15
		Low	Medium	Medium	Medium	Medium
Minor	2	2	4	6	8	10
		Negligible	Low	Low	Low	Low
Minimal	1	1	2	3	4	5
		Negligible	Negligible	Negligible	Negligible	Negligible

Table A3 – Risk assessment matrix used for CCARP Round 4

Appendix B – CCARP Round 4 Climate Change Risk Assessment

Northern Gas Networks (NGN) Climate Change Adaptation Risk Assessment

Version 3
Date Dec-24

Notes
Assessment prepared for CCARP Round 4 using same methodology and individual risks from NGN CCARP Round 3 Report
2050 and 2100 assessment based on continued operation of gas networks as current and current levels of climate change adaptation
Future climate change signal for 2050 (combined 2C and 4C) and 2100 (4C) taken from findings of ENA project undertaken with Met Office for RCP 8.5 scenario and CS-NDW project
Future climate change signal for 2100 (4C) taken from findings of ENA project undertaken with Met Office for RCP 8.5 scenario and CS-NDW
Future climate change signal for 2100 (2C) taken from UKCP18 for RCP 4.5
Above ground assets comprise offtakes, pressure reduction stations, district governors and service governors located at ground level and above
Risk assessment reflects network wide assessment of impact, local impacts on an individual asset scale may be more significantly impacted but with a relatively low overall impact to NGN network operation
Risks identified to be of medium or greater currently or in 2050 or 2100 are identified for further mitigation in NGN Climate Resilience Strategy: https://www.northerngasnetworks.co.uk/wp-content/uploads/2024/12/A8-Climate-Resilience-Strategy.pdf

Risk Assessment Colour Legend
Negligible
Low
Medium
High

				Likelihood					Consequence					Risk								
Risk Code	**Climate Variable**	**Future Climate Change Signal**	**Potential Impact on NGN**	**2024**	**2050 (2C and 4C)**	**2100 (2C)**	**2100 (4C)**	**2024**	**2050 (2C and 4C)**	**2100 (2C)**	**2100 (4C)**	**2021 (CCARP3)**	**2024**	**2050 (2C and 4C)**	**2100 (2C)**	**2100 (4C)**	**2050 Qualitative Confidence (high / medium / low)***	**2100 Qualitative Confidence (high / medium / low)***	**CCARP4 narrative and current mitigation measures**	**Assumptions (including regulatory risks)**
CCR21-1			Flooding of above ground assets resulting in malfunction and damage	2	3	3	4	3	3	3	3	9	6	9	9	12	Medium	Low	Clear climate signal that frequency and intensity of flooding events is likely to increase in future. There is a risk of physical damage to core gas assets located in flood plains (fluvial) or to other assets from extreme and extended rainfall (pluvial) with ancillary instrumentation and communication equipment being the most vulnerable, although governors and pressure reducing equipment are inherently resilient and capable of operating when submerged in water. This will be exacerbated if flood defences are ineffective and/or plant relocation is not possible. Infrastructure assets at high risk of flooding, or with previously having undergone flooding, are identified for relocation to ensure asset performance integrity. Current and 2050 risks stable between CCAR3 and CCAR4 reflecting mature understanding of risks, management procedures and asset characteristics.	The nature, composition, maintenance requirements and customer (domestic and commercial) usage of a gas network continues broadly as current into the future. Continuation of HSE mandated 30 years iron mains replacement programme to 2032 as programmed. Continuation of regulation of gas distribution networks via fixed period (currently 5 yearly) regulated business plans as current. Climate projections as per UKCP18 RCP 4.5 (2C) and RCP 8.5 (4C).
CCR21-2			Flooding of offices and depots resulting in damage to property and equipment	2	3	3	4	1	1	1	1	2	2	3	3	4	Medium	Low	Clear climate signal that frequency and intensity of flooding events is likely to increase in future. Less reliance on office and depot working since COVID-19 pandemic. Business continuity processes in place to enable key staff to work remotely to minimise impact in event of lack of access. Minimal critical equipment stored at offices and depots which cannot be sourced from elsewhere. Current and 2050 risks stable between CCAR3 and CCAR4 reflecting mature understanding of risks, management procedures and asset characteristics.	
CCR21-3			Damage to exposed and concealed pipe crossings over watercourses as a result of floodine	2	3	3	4	3	3	3	3	6	6	9	9	12	Medium	Low	Clear climate signal that frequency and intensity of flooding events is likely to increase in future. NGN operate over 2,000 pipe crossings over watercourses ('overcrossings'), of which over 80% are concealed within bridge structures and the remainder are exposed. The overcrossings include distribution mains and LTS pipelines. Damage to these pipes as a result of flooding could result in significant loss of supply and safety related incidents. All overcrossings are subject to regular inspection, with the inspection frequency determined by asset condition (every 2 to 5 years). The requirement for asset remedial measures is determined on an asset condition basis with allowances for completion of such work included with regulatory funding. Current and 2050 risks stable between CCAR3 and CCAR4 reflecting mature understanding of risks, manaement procedures and asset characteristics.	
CCR21-4			Flooding of above ground assets as a consequence of catastrophic dam failure resulting in malfunction and damage	1	1	1	1	4	4	4	4	4	4	4	4	4	Medium	Medium	Clear climate signal that frequency and intensity of flooding events is likely to increase in future. Extreme precipitation can lead to dam overload and failure. Where assets are located far enough away from dams the impact of water inundation from a dam burst is no different from "standard" pluvial, fluvial or tidal flooding, and flooding impacts can be considered similar. Where assets are close enough to dams to be impacted by the full force of a breach, the damage would be substantial. Plant and equipment would not only be impacted by water ingress, but are likely to be physically damaged or washed away by the force of water. NGN have very few assets located within dam related flood impact areas so this is a very low likelihood of occurrence. Current and 2050 risks stable between CCAR3 and CCAR4 reflecting mature understanding of risks, management procedures and asset characteristics.	
CCR21-5			Flooding of critical IT systems at third party sites	1	1	1	2	2	2	2	2	2	2	2	2	4	Medium	Low	Clear climate signal that frequency and intensity of flooding events is likely to increase in future. Potential impact on business operations as a result of flooding related loss of critical third party IT systems. All of the critical systems and servers utilised by NGN are hosted in high specification tier 3+ datacentres, all of these sites have significant risk assessments carried out on natural hazard items, including flooding, and risks from internal flooding, such as from burst pipes. These facilities have additional resilience via backup running a significant distance away so should there be an event like a flood or another natural or physical disaster, equipment can operate in isolation from the other site and not impact any live services in NGN. Supplier mitigation measures and business continuity plans are confirmed by NGN during tender events. NGN's migration to cloud based working has significantly reduced the financial impacts of such an event occurring. Current and 2050 risks stable between CCAR3 and CCAR4 reflecting mature understanding of risks, management procedures and asset characteristics.	
CCR21-6			Flooding resulting in access difficulties to key assets, offices and depots and operational activities (such as responding to gas emergencies or maintenance activities)	2	3	3	4	2	2	2	2	4	4	6	6	8	Medium	Low	Clear climate signal that frequency and intensity of flooding events is likely to increase in future. Less reliance on office and depot working since COVID-19 pandemic. Business continuity processes in place to enable key staff to work remotely to minimise impact in event of lack of access. Minimal critical equipment stored at offices and depots which cannot be sourced from elsewhere. Increasing amount of remotely operated equipment minimising impact of lack of site access, eg remote system pressure management. NGN coordinate with emergency services to ensure our gas emergency services can continue to be provided where required in communities impacted by flooding events. Current and 2050 risks stable between CCAR3 and CCAR4 reflecting mature understanding of risks, management procedures and asset characteristics.	
CCR21-7			Damage to underground pipes from river erosion (bed and banks), including landslides.	2	3	3	4	3	3	3	3	8	6	9	9	12	Medium	Low	Clear climate signal that frequency and intensity of floodng events is likely to increase in future. Pipelines can become exposed and are then susceptible to physical damage from external impact or from being unsupported, with the main risk being the scouring and erosion of pipeline coatings. More frequent flooding and increased river and watercourse flows will increase the potential for such damage and an increase in pipeline exposure by erosion is currently being experienced (previously typically 1 event per year now rising to 2). Proactive monitoring and inspection regime in place to monitor asset condition (for signs of ground movement and loss of cover soil), with frequency determined by individual site risk. This includes linewalking surveys and diver surveys for river bed crossing for LTS pipelines. Current and 2050 risks stable between CCAR3 and CCAR4 reflecting mature understanding of risks, management procedures and asset characteristics.	
CCR21-8			Groundwater or surface water flooding resulting in water ingress of below ground assets resulting in asset malfunction/damage, potential for more loss of gas events.	2	3	3	3	2	2	2	2	6	4	6	6	6	Medium	Low	Clear climate signal that frequency and intensity of surface water flooding events is likely to increase in future. Groundwater flooding occurrence likely to increase in future but signal is more complicated. Despite the inherent resilience of pipelines, more frequent and prolonged flooding will increase the risk of physical damage and the likelihood of water ingress leading to operational and supply issues. Impacts are typically observed in low pressure network and can be managed via typical operational practices, with increases in frequency of events seen over 21st century to date necessitating innovation of new equipment and techniques (such as combined cameras and pumps for narrow diameter mains) and investment in new equipment (water extraction tankers). The move to greater proportion of plastic (PE) pipes as part of the 10 year iron mains replacement programme should help to balance the impacts of increased occurrences of flooding or high groundwater in future. Groundwater flooding can also result in increased pipeline buoyancy thereby exerting additional stresses on pipelines thereby increasing the potential for damage. Increased buoyancy can also increase the likelihood of third party damage to pipelines due to reduced depths of cover. This would necessitate additional pipeline cover to counteract buoyancy. Minimal examples to date. Pipeline inspection programme (see CCR21-7) would identify these situations and enable them to be addressed. Current and 2050 risks stable between CCAR3 and CCAR4 reflecting mature understanding of risks, management procedures and asset characteristics.	
CCR21-9		Predicted increase in winter rainfall and summer droughts, increase in number of prolonged and short term extreme rainfall events	Mobilisation of soil contaminants at flooded sites	2	2	2	2	2	2	2	2	4	4	4	4	4	Medium	Low	Clear climate signal that frequency and intensity of flooding events is likely to increase in future. Flooding of contaminated sites (such as former gasworks sites) will lead to faster and greater transportation of contaminants in groundwater, especially for sites located within flood plains. This could lead to increased inspection and remediation costs to mitigate any damage and potential resultant regulatory and enforcement action. NGN's proactive land remediation management programme instigated in 2014 reduces the potential impact of contaminant mobilisation and migration. Site flood risk rating is taken into consideration in site specific contamination risk assessments which inform the requirement for remediation. Current and 2050 risks stable between CCAR3 and CCAR4 reflecting mature understanding of risks, management procedures and asset characteristics.	
CCR21-10			Asset damage from snow and ice accumulation	3	2	2	1	2	2	2	2	6	6	4	4	2	Medium	Medium	Clear climate signal of overall general future reduction in occurrence of snow and ice events, however potential remains. The risk to above ground assets is expected to gradually decrease due to less frequent snow and ice events. However, a risk remains of physical damage from excessive snow or ice falls, for example increased loading on building roofs. Current and 2050 risks stable between CCAR3 and CCAR4 reflecting mature understanding of risks, manaement procedures and asset characteristics.	
CCR21-11	Precipitation	Significant cold spells remain - predicted decrease in frequency but equally or potentially more severe	Significant / prolonged ice and snow events resulting in access difficulties to key assets, offices and depots and operational activities (such as responding to gas emergencies or maintenance activities)	3	2	2	2	3	3	2	2	9	9	6	4	4	Medium	Medium	Clear climate signal of overall general future reduction in occurrence of snow and ice events, however potential remains. Dedicated extreme weather contingency measures are already in place to ensure business continuity of key customer service requirements during snow and ice events (including training reservists and procedures to re-assign workforce and contractors to support critical activities). Business continuity procedures are in place to mitigate potential impacts, including remote cloud based working (as tested during COVID-19 period) and storage of supplies across multiple locations. Increasing amount of remotely operated equipment minimising impact of lack of site access, such as remote system pressure management. Current and 2050 risks stable between CCAR3 and CCAR4 reflecting mature understanding of risks, management procedures and asset characteristics.	
CCR21-12			Above ground asset performance impacted by raised temperatures	2	3	4	4	2	2	2	2	6	4	6	8	8	Medium	Low	Clear climate signal of long-term general increase in temperatures and increase in the number of extreme temperature days. Gas network assets are predominantly mechanical and manufactured to international standards and designed to operate within particular temperature parameters, which include those currently experienced in the UK and the expected average increases over the course of the century. Increasing temperature impacts all plant and equipment and acute and chronic increases could affect rating and asset performance, most notably ancillary IT and telecommunications equipment. However, core gas equipment is inherently resilient and designed to operate at high temperatures (in excess of any expected average increase) and there should be minimal impact on the gas network controls. The long-term chronic impact of raised temperatures is considered to primarily related to specifications and ensuring that assets, components, equipment and techniques continues to operate satisfactorily and will require ongoing consideration. Current and 2050 risks stable between CCAR3 and CCAR4 reflecting mature understanding of risks, management procedures and asset characteristics.	
CCR21-13			Above ground asset performance impacted by increased occurrence of lightning storms / strikes	3	3	3	3	1	1	1	1	3	3	3	3	3	Medium	Low	Increased storm frequency can lead to an increased lightning strike frequency, however there is no clear climate signal about likelihood or intensity of increased lightning storm frequency in the future. The majority of gas network assets are underground and therefore not significantly at risk. Where lightning strikes exposed assets, this could cause physical damage and failure. This may lead to operational failure, loss of telecommunications equipment, and a fire risk to gas venting stacks. Gas network assets are provided with high degrees of earthing protection and occurrences of lightning strikes are currently very rare. Current and 2050 risks stable between CCAR3 and CCAR4 reflecting mature understanding of risks, manaement procedures and asset characteristics.	
CCR21-14			Heat impacts on employees, such as heat exhaustion and/or loss of productivity in extreme temperatures, and requirements for additional mitigation, such as air conditioning and different PPE	2	3	3	4	1	1	1	2	1	2	3	3	8	Medium	Medium	Clear climate signal of general increasing temperature and number of extreme temperature days. Business implications anticipated to be manageable within business as usual, for example by selection of alternative personal protective equipment or review of working practices. Current and 2050 risks stable between CCAR3 and CCAR4 reflecting mature understanding of risks, management procedures and asset characteristics.	
CCR21-15			Heat impacts on critical operational procedures, such as performance of chemical sealants used in gas emergency repairs or PE pipe fusion performance, in extreme temperatures	1	2	2	3	2	2	2	2	2	2	4	4	6	Medium	Low	Clear climate signal of general increasing temperature and number of extreme temperature days. No currently known issues. This requires surveillance and may require future amendment to operational materials and procedures. Current and 2050 risks stable between CCAR3 and CCAR4 reflecting mature understanding of risks, management procedures and asset characteristics.	
CCR21-16		Predicted increase in temperatures and increase in number of extreme temperature days	Critical (own and third party assets) IT systems performance impacted by raised temperatures	1	1	1	2	2	2	2	2	2	2	2	2	4	Medium	Low	Clear climate signal of general increasing temperature and number of extreme temperature days which can impact IT system performance. NGN and third party facilities provided with climate control to reduce potential for overheating and malfunction. Business continuity requirements for third party providers discussed in CCR21-5. Current and 2050 risks stable between CCAR3 and CCAR4 reflecting mature understanding of risks, management procedures and asset characteristics.	
CCR21-17	Temperature	Significant cold spells remain - predicted decrease in frequency but equally, or potentially more, severe	Increasing average winter temperatures overall reducing gas demand for heating potentially leading to perceived requirement for reduced investment in gas networks. Potential for intense winter cold snaps remains necessitating investment in gas network to perform appropriately (reispond to 1 in 20 winter peak demand).	1	1	1	1	4	4	4	4	4	4	4	4	4	Medium	Medium	Clear climate signal of overall general future warming with reduction in occurrence of significant cold events, however potential remains and they could be more severe than current in future. NGN's gas network has an enduring requirement to be operated and maintained to meet 1-in-20 year peak demand requirements during periods of intense cold to ensure customer requirements are met in accordance with regulatory network performance requirements as set by Ofgem, BEIS and the Health and Safety Executive. Continued investment is requirement to ensure continuity of this resilience. NGN is a regulated business and is required to submit regular (currently every five years) regulatory business plans for approval which are required to include details of our asset management plans to ensure that we operate a safe, resilient and sustainable network to meet customer demands even during extreme weather events, in particular extreme cold weather. In addition, we are also required to submit annual regulatory performance reports detailing our asset management activities and customer and safety performance. This regulatory framework reduces the likelihood of this risk occurring. Should gas networks undergo future partial or sequential decommissioning this would create more single-feed sub-networks. These would have lower supply continuity resilience than currently and may need reinforcement investment to retain supply resilience at current levels. This necesiary investment would be spread over a smaller customer population potentially increasing affordability issues. Alternatively, if such investment did not materialise, it poses the risk of leaving gas customers, some of whom will include those who cannot switch from gas due to cost issues or their local electricity network configuration, with reduced levels of energy supply resilience and therefore facing greater levels of vulnerability. Current and 2050 risks stable between CCAR3 and CCAR4 reflecting mature understanding of risks, management procedures and asset characteristics.	
CCR21-18			Underground asset damage as a result of cycles of dry and wet weather resulting in ground movement. Cold temperatures can also result in ground heave and asset damage.	2	1	1	1	3	3	3	3	6	6	3	3	1	Medium	Low	Ground movement caused by repeated cycles of soil shrinkage and swelling (in particular in clay soils) will exert tensile forces on underground assets, especially to more vulnerable joints and connections, with cast iron mains presenting the highest risk. Steel pipelines and plastic mains / services are inherently more resistant to ground movement. Ground movement could lead to mechanical damage and the potential fracture of pipelines or mains, plus also joint movement or corrosion damage for mains, leading to a serious risk of gas release or explosion. Ground movement can also result from cold temperatures (frost heave). Any loss of ground cover above pipes could also increase the risk of third party strikes. To date NGN has not been able to identify a clear correlation between soil and weather data and locations and occurrences of pipe fractures for our assets and region, however it is understood that other utility networks are identifying trends. Increasing use of plastic (polyethylene (PE)) pipe for mains offers more flexibility, and therefore resilience, compared to more brittle metallic (iron) pipe which will reduce the impacts of ground movement. Currently approximately 80% of NGN's pipe network is PE, with the 30 year, risk-based Iron Mains Replacement Programme due to be completed by 2032 to remove all iron mains located within 30m of properties. By 2050 it is anticipated that c.100% of distribution mains will be plastic. The high pressure pipe network is constructed of heavy wall steel pipe which is more resistant to ground movement than iron and is also subject to an inspection programme to observe for loss of cover soils or signs of ground movement (see CCR21-7). Current and 2050 risks stable between CCAR3 and CCAR4 reflecting mature understanding of risks, management procedures and asset characteristics.	
CCR21-19	Temperate and precipitation	Winters getting warmer and wetter, summers getting hotter and drier Increasing occurrence of wet-dry cycles of weather	Increased vegetation growth rates and longer vegetation growing season resulting in increased maintenance requirements to ensure gas infrastructure site performance is not impacted and customer complaints for 'untidy' sites do not increase	4	5	5	5	1	1	1	2	4	4	5	5	10	High	Medium	Clear climate signal of generally warmer conditions anticipated to result in longer vegetation growing seasons. Above ground assets will be impacted by any increased growth of trees adjacent to operational equipment and access/egress points. Increased vegetation management requirements are anticipated, although additional costs are likely to be relatively low and manageable within business-as-usual practices. Any change in the numbers or seasons of nesting birds and protected species will need to be registered on habitat surveys and could potentially restrict work activities. Existing management procedures are in place to ensure projects can be appropriately completed around site ecological restrictions. Such management procedures will need to be regularly reviewed to ensure they review fit for purpose and continue to offer appropriate level of control as current. Impacts are expected to be of relatively low significance. Current and 2050 risks stable between CCAR3 and CCAR4 reflecting mature understanding of risks, manaement procedures and asset characteristics.	
CCR21-20			Storm damage to above ground assets (structural damage and resultant asset performance).	2	3	3	3	2	2	2	2	4	4	6	6	6	Medium	Low	Climate signal of increasing windstorm frequency with extreme events of similar intensity to current. Assets are potentially subject to damage from extreme weather events including storms and high winds. Any increase in the frequency and severity of these events will mean a higher risk of infrastructure damage and failure and an impact on support services. Gas network assets are mainly located underground, and above ground equipment is designed and constructed to be resilient to storms, although a level of risk remains from extreme weather events. Electrical and instrumentation control equipment are the most vulnerable assets, and may need to be protected or housed if located in exposed areas. Proactive vegetation management is undertaken to reduce the potential impact of storm damage. Current and 2050 risks stable between CCAR3 and CCAR4 reflecting mature understanding of risks, management procedures and asset characteristics.	
CCR21-21	Wind	Increasing windstorm frequency (particularly when following high intensity precipitation), similar extreme event intensity to current	Storm damage to offices and depots	2	3	3	3	2	2	2	2	4	4	6	6	6	Medium	Low	Climate signal of increasing windstorm frequency with extreme events of similar intensity to current. Offices and buildings are subject to wind damage or damage from trees, so effective vegetation management practices and building maintenance procedures assist in reducing any risk. Limited potential business impact. Current and 2050 risks stable between CCAR3 and CCAR4 reflecting mature understanding of risks, management procedures and asset characteristics.	
CCR21-22	Wild fire	Increased likelihood as a result of hotter, drier summers	Asset damage from increased occurrence from wildfire	2	3	3	4	2	3	3	3	6	4	9	9	12	Low	Low	Wildfire is a consequential risk of increased temperatures and reduced precipitation and, whilst difficult to forecast, poses a significant risk to above ground assets where they are located in susceptible areas. These include open heathland, grassland or forested areas and may be in remote locations. The risk of above ground infrastructure damage is increased in the absence of vegetation clearance within 3m of site boundaries. Wildfire risks to underground pipelines is limited and previous advice provided to NGN identified that vertical heat penetration from surface wildfire is limited to c0.5m deep and thereby poses no significant risks to underlying pipes given the typical depths of cover. There is an interdependent risk from any impact on other utility assets such as electricity lines and substations and telecommunication lines. New and emerging risk with current low risk to gas infrastructure, typically limited to rural AGIs and offtakes, but requires surveillance. Low confidence rating reflective of this. Reduced current risk in CCAR4 compared to CCAR3 to reflect greater focus on vegetation manaement and improved recognition of risk. No change to 2050 risk.	
CCR21-23			Tidal flooding of above ground assets resulting in malfunction and damage	2	3	3	4	3	3	3	3	9	6	9	9	12	Medium	Low	Clear climate signal of sea level rise and increased storm surge occurrence likely to increase tidal flooding. Core gas assets have high degree of integral resilience to flood impacts although would be susceptible to large tidal inundations. Comments as per CCR21-1.	
CCR21-24			Tidal flooding of offices and depots resulting in damage to property and equipment	2	3	3	4	1	1	1	1	2	3	3	3	4	Medium	Low	Clear climate signal of sea level rise and increased storm surge occurrence likely to increase tidal flooding. Comments as per CCR21-2.	
CCR21-25			Damage to exposed and concealed pipe crossings over watercourses as a result of tidal floodine	2	3	3	4	3	3	3	3	6	6	9	9	12	Medium	Low	Clear climate signal of sea level rise and increased storm surge occurrence likely to increase tidal flooding. Comments as per CCR21-3.	
CCR21-26			Tidal flooding of critical IT systems at third party sites	1	1	1	2	2	2	2	2	2	2	2	2	4	Medium	Low	Clear climate signal of sea level rise and increased storm surge occurrence likely to increase tidal flooding. Comments as per CCR21-5.	
CCR21-27			Tidal flooding resulting in access difficulties to key assets, offices and depots and operational activities (such as responding to gas emergencies or maintenance activities)	2	3	3	4	2	2	2	2	4	4	6	6	8	Medium	Low	Clear climate signal of sea level rise and increased storm surge occurrence likely to increase tidal flooding. Comments as per CCR21-6.	
CCR21-28			Coastal flooding resulting in water ingress of below ground assets resulting in asset malfunction/damage, potential for more loss of gas events	2	3	3	3	2	2	2	2	4	4	6	6	6	Medium	Low	Clear climate signal of sea level rise and increased storm surge occurrence likely to increase tidal flooding. Impacts typically observed in low pressure network and can be managed via typical operational practices as per comments for CCR21-8. Move to greater proportion of plastic (PE) pipes help to balance impacts of increased occurrences of flooding or high groundwater in future. Impact restricted to tidal/coastal areas thereby limiting impact. Current and 2050 risks stable between CCAR3 and CCAR4 reflectine mature understandine of risks. manaement procedures and asset characteristics.	
CCR21-29	Sea level rise / Storm Surge	Sea levels predicted to rise Increased frequency of storm surges	Saline groundwater contamination resulting in corosion damage to underground metallic pipelines	2	2	2	3	2	2	2	2	4	4	4	4	6	Low	Low	There is a risk of gradual chemical damage to pipelines from increased tidal flooding, which will affect asset integrity and could lead to water ingress and gas release. Ingress of saline groundwater may also impact the buoyancy of pipes and cause structural issues. Impacts are mitigated by the use of cathodic protection and pipeline inspection programme (see CCR21-7). Understanding of the potential and likely impacts of this risk for NGN's region and asset are nascent and it will require further consideration. Current and 2050 risks stable between CCAR3 and CCAR4 reflectine level of understandine of risks. manaement procedures and asset characteristics.	
CCR21-30	Coastal erosion	Increased likelihood as a result of sea level rise and increased frequency of storm surges	Asset damage / loss from coastal erosion	1	2	3	3	2	2	2	2	3	2	4	6	6	Medium	Low	Yorkshire coast, located in NGN network area, is well established as a coastal erosion hotspot. Minimal NGN infrastructure is located within close proximity (1km) of unprotected eroding stretches of coastline therefore potential for infrastructure damage is limited. Assumed that infrastructure present within urban coastal areas will continue to be protected from coastal erosion to current standards in the long-term. Monitoring of this risk will be required into the future. Current and 2050 risks stable between CCAR3 and CCAR4 reflecting level of understanding of risks, management procedures and asset characteristics.	
CCR21-31			Interdependencies of electricity and gas networks - such as increased temperatures resulting in increased demand for cooling and resultant increase in electricity demand from gas fuelled powerstations; or flooding of electricity substations resulting in loss of supply to gas sites	2	3	3	3	2	2	2	3	4	4	6	6	9	Medium	Low	Requires close coordination between gas and electricity networks in particular as energy networks become integrated into the future. Excess gas usage by commercial users unlikely to occur as consumption rates are set in connections legal agreements and generally decreasing over time. Potential risks from loss of electricity supply to infrastructure sites associated with issues with electricity network is likely to increase over time due to increased extreme weather events, but impact is limited as key NGN sites have own backup generators, and key mechanical elements of the gas network can perform key functions without electricity supply. NGN are investigating over the remainder of this decade to improve backup power provision on key infrastructure sites to further reduce the impact of such events. Current and 2050 risks stable between CCAR3 and CCAR4 reflecting mature understanding of risks, management procedures and asset characteristics.	
CCR21-32			Interdependencies with electricity and telecommunications networks - potential for loss of power and communications with asset sites during extreme weather events locally, or wider regionally, having impacts on third party network performance	2	3	3	3	2	2	2	3	4	4	6	6	9	Medium	Low	Increasing digitalisation is likely to increase business criticality of telecommunications and electricity systems to gas network operation. Potential risks from loss of electricity supply to infrastructure sites associated with issues with electricity network is limited as key NGN sites have own backup generators, and key mechanical elements of the gas network can perform key functions without electricity supply thereby limiting impact. NGN are investigating over the remainder of this decade to improve backup power provision on key infrastructure sites to further reduce the impact of such events. Loss of public telecommunications does not typically impact critical core gas asset performance as they are operated via a resilient SCADA network, however can impact by disrupting communications with field staff and some operational technology. Impacts are typically short term disruption / small scale resource implications (such as requirement to dispatch field technicians to check site conditions as experienced currently when snow/ice interrupt site satellite dish communications). Future innovations in communications networks are likely to ameliorate potential increased future risks associated with this in the future. Current and 2050 risks stable between CCAR3 and CCAR4 reflectine mature understandine of risks. manaement procedures and asset characteristics.	
CCR21-33			Supply chain impacts - vulnerability / resilience of key suppliers of goods and services to climate change impacts	3	4	4	4	2	2	2	2	6	6	8	8	8	Low	Low	Supply chain business continuity management plans could be affected due to severe weather impacting manufacturing and material storage facilities, or creating logistics difficulties. Recent similar examples have been experienced for non-climate related incidents, eg Suez Canal blockage. This can result in reduced capability and support from supply chain businesses and impact on the continued network operation and maintenance in extreme cases. To mitigate against these risks NGN have developed a new Workforce and Supply Chain Resilience Strategy which includes commitments to supply chain diversification, improved inventory management, and improved transport and logistics provision to provide increased business resilience. This requires constant evaluation and management. Current and 2050 risks stable between CCAR3 and CCAR4 reflecting mature understanding of risks, management procedures and asset characteristics.	
CCR21-34	All	See above	Changes in wildlife patterns impacting network operations, eg longer nesting bird season	3	4	4	5	1	1	2	2	3	3	4	8	10	Low	Low	The effects of climate change could lead to impacts on wildlife due to changes in environments, habitats, and behaviours. This could lead to restricted access to assets from changed nesting habits, prolonged nesting seasons, changes to species migration, subsidence from burrowing etc. Impacts are anticipated to be minimal and capable of being managed by business as usual practices. Current and 2050 risks stable between CCAR3 and CCAR4 reflecting mature understanding of risks, management procedures and asset characteristics.	

* Confidence rating assessment matrix
High Certain about likelihood and significance
Medium Uncertain about likelihood or significance
Low Uncertain about likelihood and significance

	2021	2024	2050 (2C and 4C)	2100 (2C)	2100 (4C)
Negligible	11	11	9	8	4
Low	15	16	18	20	22
Medium	8	7	7	6	8
High	0	0	0	0	0
Total	**34**	**34**	**34**	**34**	**34**