Climate Change Adaptation Report: 4th Round

December 2024

SGN

Your gas. Our network.

Contents

Introduction

Organisational profile

SGN is a privately owned Gas Distribution company, operating over 70,000km of gas mains and services in the south and southeast regions of England and the whole of Scotland under the banner of SGN. It is the UK's second largest Gas Distribution network (GDN) company and is responsible for delivering gas to its 6 million customers safely, reliably, and efficiently.

Our Scotland network distributes gas across all of Scotland to 75% of households, including remote areas through the Scottish Independent Undertakings (SIUs) at Stornoway, Wick, Thurso, Oban and Campbelltown.

Our Southern network stretches from Milton Keynes in the north, to Dover in the east and Lyme Regis in the west, including London boroughs to the south of the River Thames, distributing gas to around 90% of households.

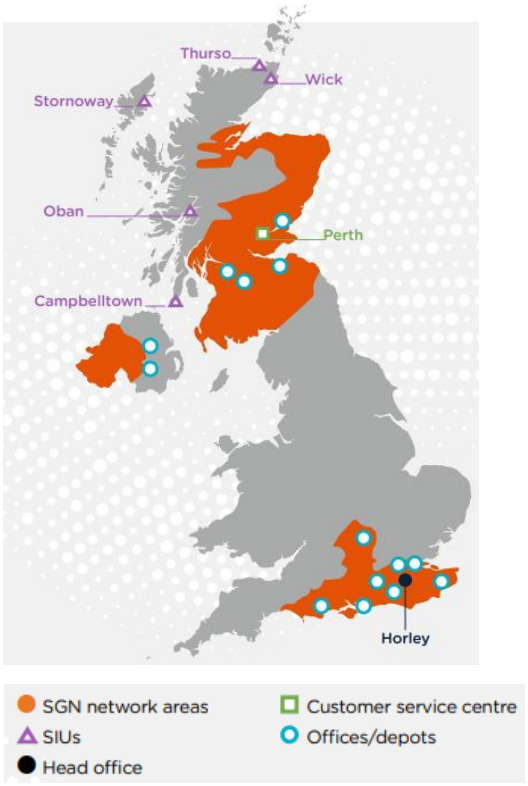


Figure 1: SGN locations and areas

Governance, management and strategy

SGN is regulated by the Office of Gas and Electricity Markets (Ofgem) and are also subject to common statutory requirements overseen by the Department for Energy Security and Net Zero (DESNZ), the Health and Safety Executive (HSE), the Environment Agency (EA) and the Scottish Environment Protection Agency (SEPA). Climate risk and resilience is a key part of our Environmental Strategy and our latest progress can be seen in our Annual Environmental report. Most recently we have finalised our Climate Resilience Strategy (see our website) which looks at the climate change risks to our operational network sites and property. It considers the wider risks and uncertainty, and costs associated with real examples of climate change impacts to our network. Some key areas of our climate resilience strategy are included in this report.

We have ISO14001:2015 accreditation but not any of the adaptation specific ISO standards or similar.

Energy Networks Association

Energy Networks Association (ENA) is the trade association for the energy networks. Its members own and operate the infrastructure which carries electricity and gas into your community. Though SGN (and the other gas distribution networks) are no longer members of the ENA, we have still contributed at a high level to the collaborative 4th Round Climate Change Adaptation Report by the ENA's Adaptation to Climate Change Task Group. The ENA report provides an update on existing risks, mitigation measures and programmes, as well as consolidating the Gas and Electricity network reports to provide an Energy Networks sectoral response. Some of the common narrative around method and data in this report are taken from the collaborative ENA sector response.

Method

The development of the report follows the requirements and guidance set out by the Department for Environment, Food and Rural Affairs (DEFRA) to establish current risk against various climate hazards. Allowed revenues for the industry are currently set by Ofgem in periodic price reviews and therefore any costs associated with adaptation to climate change need to be agreed with Ofgem. As a gas distribution company SGN is responsible for transporting gas to customers up to the point of the gas meter. Under the terms of the

Civil Contingencies Act, we are Category Two responders and work closely with other utilities, the emergency services and local authorities.

Security of supply levels are agreed with Ofgem and these standards, and processes to maintain the availability of alternative supplies, allows for loss of sections of the networks. However, they do not provide for certain low probability events including multiple failures or the total failure of the network. Particular attention must therefore be given to key sites when considering network resilience as the entire network cannot be resilient.

Climate change data

ARP3 included the involvement of the Met Office UK Climate Projection (UKCP18) tool to consider projections towards the end of the 21st century. In 2020, on behalf of its members, ENA commissioned the Met Office to undertake a review of the UKCP18 data and provide an RCP 8.5[1] worst case scenario to understand the changes in potential impact to energy infrastructure assets from climate change. The report from this research has been used to assess the current risks to the energy network, and to guide future mitigation or management actions. In addition, other tools including the Landmark flood mapping tool, have been used for research and risk assessment independent to the ENA Met Office research.

In summary, the Met Office assessment concluded:

- many of the hazards identified are projected to increase due to future climate change, including, increased frequency of high temperature days, prolonged rainfall events, hourly rainfall extremes, sea level rise, extreme sea level events, increased risk of wildfire and increased extreme diurnal cycle events;
- the frequency of snow and ice days are expected to decrease; and
- with regards to societal response to climate change, the assessment considered that impacts of weather hazards on the energy network are likely to come in the form of an altered dependency between weather and both supply and demand, impacting forecast accuracy.

ARP4 does not offer any new climate change data or tools to navigate climate change risks but does retain the research made during ARP3. ARP3 was published in 2021 and there has been little variation between the data provided in ARP3 and the current round of reporting. Therefore, the ENA members from the electricity and gas networks did not identify reasonable justification to commission for further climate change research. The scenario used for gas ARP4 risk data is based on the Met Office's predicted 4°C degree scenario (RCP 8.5) which is suggested to occur by close of the current century if global emissions continue unabated at their current rate. SGN justify the choice of omitting the 2°C degree projections (RCP 2.6, RCP 4.5 and RCP 6.0) as the industry primary adapts to worse-case scenarios and any adaptation and mitigation progress towards the 4°C scenario will encompass 2°C scenarios by default.

RCP 8.5 project the following predictions:

In comparison to 1990's climate, by 2070:

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

Differences between our Scotland and Southern networks

Our dispersed networks to some extent face different climate-related risks and challenges but analysis of emergency and repair workload trends still shows how weather continues to be the biggest influencing factor

[1] RCP 8.5 is a high-emission pathway, where greenhouse gas emissions continue to grow unmitigated.

for both networks. Further analysis of climate scenarios and the potential increased risks associated with an increasing likelihood of extreme weather events is required to fully assess the difference between our Scotland and Southern networks and the actions required to ensure safe and resilient networks in the long term.

The UK Government funded report by CS N0W '*Enhancing resilience in UK energy networks-What are the future weather and climate risks to energy network infrastructure?*' published in October 2023 has also informed some of the high-level risk review process. The overarching risks in Scotland and southern England differ slightly as overviewed below but operationally we have already started seeing far more climate-related impacts affecting our Scotland network. For example, in Scotland we have had 108 pipeline washouts compared to 1 in southern. A washout is where parts of our pipeline near rivers and under river crossings have been washed away due to heavy rainfall and river erosion. Pipelines exposed in this way present a safety hazard as well as potential disruption to customers if the pipeline were to break and leak gas. We have included case studies of recent weather events which have caused significant impact to our networks in Appendix A.3.

Table 1: Overview of SGN risks from CS N0W report

	Wind Storms	Hot Spells	Wet Spells	Cold Spells
Scotland	Little change up to 2060	Increase of 1 in 20 yr event to 1 in 5 yr event between 2020-40 and annually from 2060-80	Little change up to 2060	Warmer and less severe
Southern England	No change up to 2060	More regular and hotter between 2020-2040 and increases between 2060-80	Little change	Warmer and less severe

Future risk scores

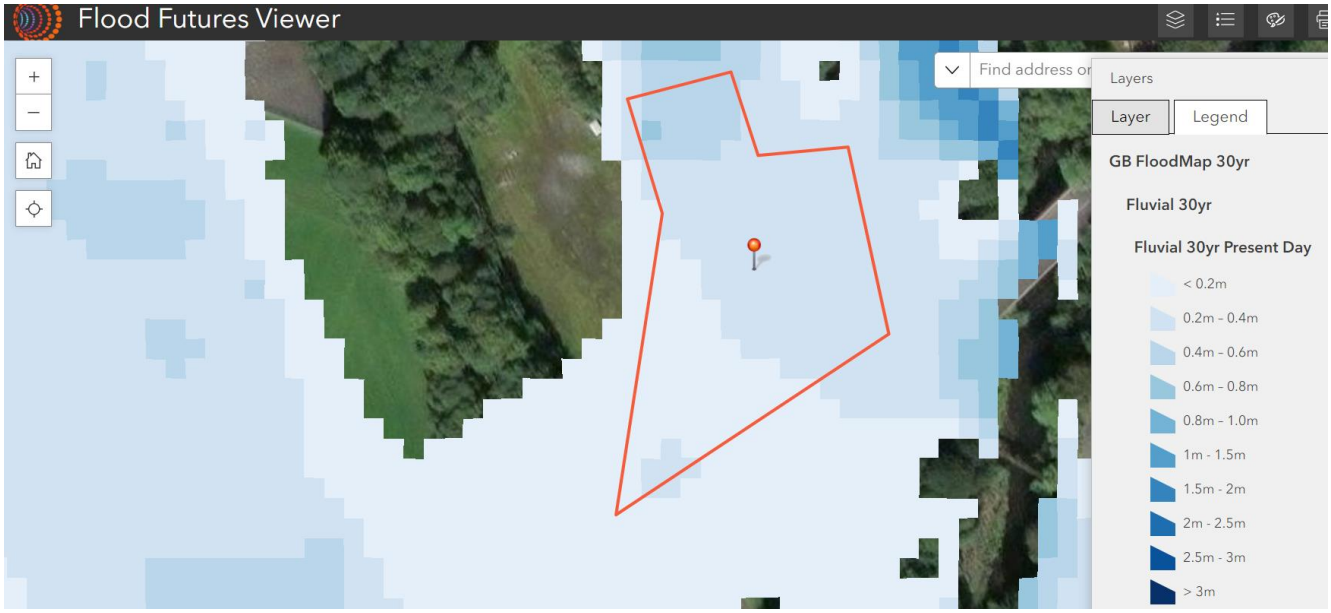
Future Risk Scoring for 2050 and 2100 have not been reviewed as part of ARP4 so have not been included here. Though we are aware climate change impacts are likely to increase, the future of the gas network beyond 2050 still has some uncertainty whilst we await government decisions on heat policy. Future climate projections are speculative and reduce in accuracy the further in the future the prediction is made. Scoring for 2050 and 2100 are expected to be subject to unseeable variables and are therefore accompanied by a reduced confidence rating beyond 2050/2070. We will provide an update on 2050 and 2100 scores in the next risk assessment.

Landmark flood maps

In 2021 we received funding from OFGEM to purchase Landmark Flood Futures software to better assess the risk of our sites under different climate scenarios. Though we still have work to do in this area the outputs of the dataset are useful in informing decisions for asset upgrade, site relocation, pipeline diversions and similar works. An example of the output from the Flood futures software is shown in Figure 2 below for one of our satellite depots located in the Scottish Borders.

Water depths are shown in the legend. The location of the depot is shown by the red boundary and pin.

Figure 2: Galashiels satellite depot, fluvial flood risk under RCP 8.5 scenario by 2030



Climate change adaptation risk scores

Risks have been assessed by drawing on past and current experiences in SGN and a high-level overview of the future projections in the Met Office and CS N0W reports. For this reason, the risk scores are somewhat subjective and may be open to unconscious bias.

The overall risks have been considered in the ENA Climate change adaptation working group and it is expected the other gas distribution networks will also have similar risks, though the scoring may differ. SGN have separate networks in southern England and in Scotland and though the number of incidents may vary between regions, the overall risk scores have been agreed between them.

There are some complexities around predictions on the gas networks given the uncertainty on the future of UK heating. It is not currently known what the energy mix will look like beyond 2050 to a high level of detail, for this reason, the scoring beyond 2050 has been excluded.

In our ARP3 we disclosed 22 climate-related risks identified through collaborative work between all Gas Distribution Networks and National Gas. These risks are functional risks managed at directorate level. The changes since round 3 have been summarised in Table 2 below. The risks that have not changed since ARP3 can be found the Appendix A.2. Alongside the scoring, the mitigation progress showcases any changes or improvements since the previous round.

The change in assessment scoring between ARP3 and ARP4 is in some cases due to specific incidents and events such as pipeline washouts and riverbank erosion, and for others, like IT resilience, the score has reduced due to an increase in cloud-based storage and third-party IT sites.

Table 2: New and updated risk scores

Risk Code	Risk	Description	ARP3 Risk Score	Mitigation process & reason for score update	ARP4 Risk Score
ARG8	Extreme weather impacts from lightning	Increased storm frequency creates more risk from lightning. Where lightning strikes exposed assets, it can cause physical	3	Though impacts of future lightning strikes are uncertain there is some evidence winter storms could increase. We have seen secondary	8

		damage and possible operational failure, loss of telecommunications equipment, and a fire risk to gas venting stacks.		damage from lightning strikes felling trees and fencing and damaging our sites, particularly in our southern network. However, gas network infrastructure is predominantly located underground, and our above ground assets are provided with high degrees of earthing protection.	
ARG12	Ground movement due to drought conditions and dry ground	Ground movement caused by drying and shrinkage will exert tensile forces on underground assets, especially to more vulnerable joints and connections, with cast iron mains presenting the highest risk. This could lead to mechanical damage and the potential fracture of pipelines leading to a serious risk of gas release or explosion. Any loss of ground cover above pipes could also increase the risk of third-party strikes.	6	Increasing use of polyethylene pipe offers more flexibility and resilience, compared to more brittle iron pipe, reducing the impacts of ground movement. The high-pressure pipe network is constructed of transmission grade 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. Overall, we have increased the likelihood but have kept the same consequence level, particularly when drought is followed by heavy rainfall.	9
Precipitation					
ARG10	Risk to underground pipelines from river erosion and flow	Increased precipitation results in flooding and stronger watercourse flows. This hydraulic action can abrade pipeline coatings if they are exposed. Additionally, hydraulic motion can move pipes, causing bending stress from lack of support.	12	This is our most significant risk, and we have seen numerous examples of this in Scotland. We have increased the likelihood to 'almost certain' as we are seeing more than one incident a year. Mitigation of the risk includes asset condition monitoring (for signs of ground movement and loss of cover), including line-walking surveys and diver surveys for riverbed crossings, and consideration of use of drones and satellite imagery.	15
ARG11	Ground contamination and transport of materials from flooding of contaminated sites	Flooding of contaminated sites, especially sites like floodplains, can transport leeched materials via ground water. This can result in increased damage mitigation costs like remediation and inspection, additionally, risking more regulatory and enforcement action.	6	Site flood risk rating is taken into consideration in site specific contamination risk assessments which inform the requirement for remediation. There is good progress on our contaminated land programme, so the risk is reducing over time.	4
ARG23*	Culvert and field drain wash-ins from high precipitation	Some field drains are easily blocked due to increased rainfall. Causing limited access to the network if required and damage to surrounding areas	N/A	New and emerging risk for ARP4. Drains have been repaired and/or upsized when identified preventing future risk. Assessment could be carried out on higher risk areas.	6

Temperature and Precipitation					
ARG14	Asset damage if no wildfire risk assessment or remediation measures	Increased temperatures and reduced precipitation increase the occurrence of wildfires, posing a significant risk to above ground assets that are susceptible. Underground pipeline damage is more probable when vegetation clearance within 3m of site boundaries is not performed. There is also an interdependent risk from any impact on other utility assets in the electrical system.	6	Wildfire risks to underground pipelines is limited and previous advice provided to GDNs 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. In the future this may emerge as a larger risk as average temperatures increase.	4
Other					
ARG7	Damage to above ground assets from storm events	Assets are 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. Communication equipment will be the most vulnerable assets.	6	Gas network assets are mainly located underground. Above ground equipment is low rise and is somewhat 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 additional protection. Proactive vegetation management is undertaken to reduce the potential impact of storm damage. Increased likelihood to 'likely' and significance to 'moderate' due to increasing number of pipeline washout incidents from storm events.	12
ARG13	Vulnerability of critical IT systems managed by third parties from extreme weather events	This represents an interdependency with other service suppliers and there is a risk of the loss of critical IT systems and functionality, especially if there is insufficient flood protection or cooling of third-party data centres and/or these cannot be relocated. Any loss of capacity could lead to the need for manual intervention and reduced network control.	8	We now host all IT services in modern data centres which have improved environmental, security and resiliency, with significant risk assessments carried out on natural hazard items, including flooding, and risks from internal burst pipes etc. Migration to cloud-based working has significantly reduced the impacts of such an event whilst also decreasing service levels. These reasons contribute to the reduced score.	4

**ARG23 is an emerging risk identified in SGN's Climate Resilience Strategy and not through ENA collaboration group*

Management Risks					
ARG1	Lack of climate change management procedure.	The requirements for climate change management need to be specified to ensure the necessary procedures and actions are integrated into the organisation's EMS. This gives a greater understanding of the impact of climate change and improves the overall environmental culture within the business.	8	Climate change management procedures, actions and risks are integrated in our EMS, which is externally certified to ISO14001:2015. To allow a clear framework for river crossing risk, we are currently updating our Management Procedure for the inspection and maintenance of below ground pipelines and mains at river crossings and watercourses.	6
ARG2	Lack of specific policies and procedures governing risk assessment process on climate change	A robust climate risk assessment process is required for all major network investment decisions. Climate change needs to be considered at the planning stage prior to the installation of new/replacement gas and electricity infrastructure. This will result in a greater level of asset data and information and increased asset integrity.	8	The risk register considers lack of procedures and tools. Our template for investment decisions includes environmental considerations. Flooding is a key risk which is being considered for future location of assets. However, other climate risks are not considered to the same extent. We will develop adaptation pathways to consider all key climate risks.	6
ARG3	Risk and action owners not identified at senior leadership team level	Asset climate risks need to be afforded the same status as other risks to assets including security, safety, and other environmental impacts. Accountability is then required at senior management level and responsibilities included within existing business risk processes.	9	Risks associated with climate change is included in SGN's Enterprise Risk register, which is published in our Annual Report. Senior Management accountability is disclosed in our TCFD2 report. Functional risk registers and enterprise risks are reviewed on a quarterly basis and higher risk scores are discussed at executive level and at board meetings.	8
ARG17	Supply chain impacts	Business continuity can be impacted by severe transport disruption resulting from extreme weather events. This can lead to reduced capability, support and delivery from our supply chain and impact on the continued operation and maintenance of the networks.	6	With regards to services from our supply chain, this is considered as part of our Business Continuity Management Plans. We recognise there is a risk of supply chain impacts due to climate change and have yet to develop an adaptation response.	8

[2] Taskforce for Climate Related Financial Disclosures. These disclosures are reported annually in our Annual Report.

Action plan

The action plan from previous rounds of reporting has been included in table 3 below, along with the progress on these actions and any new actions identified in this report in table 4. Actions that were closed in previous reporting have not been included in this round. The review of the actions has been carried out at a high level after comparison with our recently published Climate Resilience Strategy which looks at the risk for the next regulatory funding period, RIIO-GD3.

Table 3: Previous ARP actions

Risk Code	Summary of actions (as set out in the previous rounds)	Progress on implementation of actions	Assessment of extent to which actions have mitigated risk	Benefits/challenges experienced
ARG2	A strong climate risk assessment is needed for major investment decisions. This ensures climate change is considered during planning, before installing or replacing gas infrastructure.	Implementing the TCFD (Taskforce for Climate Related Financial Disclosure) framework- **Complete** Utilise Landmark flood futures software to review risks across the sites and projects **Ongoing**	All new gas sites and refurbished gas sites are built with consideration of current and future climate change impacts throughout the asset's lifespan.	Increased confidence in investment decisions. Utilisation of climate data in areas of the business that need to consider the operational lifespan of assets.
ARG20	Increased tidal flooding poses a risk of gradual chemical damage to pipelines, affecting asset integrity and potentially leading to water ingress and gas leaks. Saline groundwater may also impact pipe buoyancy and cause structural issues. No analysis has been conducted yet to quantify this risk.	Keep a watching brief on potential issues. Any issues to be tracked on our operational risk software (Velocity) and Environment team should be informed. **Ongoing** Carry out risk analysis of coastal assets by Asset team. **Ongoing**	No current instances of damage to assets. Cathodic protection used to prevent saline groundwater damage. Our adaptation of the TCFD framework ensures climate-related risks are managed and governed appropriately.	Lack of case studies due to limited instances. Difficult to predict impact and future risk.

Table 4: ARP4 action plan

Risk Code	Summary of new actions (Round 4)	Climate risk	Timescales and Ownership	Measurement and assessment
ARG22	Review flood risk management process and incorporate a requirement to assess future climate projections for all occupied sites, operational sites and	Ground water flooding of below ground assets leading to water ingress to pipes. Pipelines can be exposed and are then susceptible to physical damage (scouring and erosion of pipeline coatings). More	Network, Property & Environment teams Mar 2026	Create procedures for using Landmark tool for network planning, property and asset. Mitigation measures, such as flood defence work and plant relocation are being included in site upgrade works. Previous flood mapping has

	pipelines over a scheduled basis depending on risk. **Also reported in previous ARP but further actions have been identified*	frequent flooding and increased river and watercourse flows will increase this level of risk.		been carried out. Example: Work has commenced on improving drainage at an offtake site that regularly floods outside of extreme weather events.
ARG1	Include climate change management aspects into procedures for inspection and maintenance of below ground pipelines and river crossings and other relevant procedures.	Risk to underground pipelines from river erosion and flow. Increased precipitation results in flooding and stronger flows. This hydraulic action can abrade pipeline coatings if they are exposed. Additionally, hydraulic motion can move pipes, causing bending stress from lack of support.	Asset Management Team Mar 2026	Update Management procedure for inspection and maintenance of below ground pipelines and mains at river crossings and water courses. Identify other relevant procedures that need updated. The risk register acknowledges climate change risks and how to manage these.
ARG2	Develop adaptation pathways to consider all key climate risks in the medium to long term which will help inform our risk score and confidence rating across the climate risk register. Consider which pathways and different scenarios we are using to consider risk.	Lack of specific policies and procedures governing risk assessment process on climate change. A robust climate risk assessment process is required for all major network investment decisions. Climate change needs to be considered at the planning stage prior to the installation of new gas infrastructure.	Environment Team, Asset Management Mar-2027	Our template for investment decisions includes environmental considerations. Flooding is a key risk which is being considered for future location of assets. However, other climate risks are not considered to the same extent. We will develop adaptation pathways to consider all key climate risks in the medium to long term which will help inform our risk score and confidence rating across the climate risk register.
ARG17	Consider the risk of climate change on our Supply chain, particularly key suppliers	Business continuity can be impacted by severe transport disruption resulting from extreme weather events. This can lead to reduced capability, support and delivery from our supply chain and impact on the continued operation and maintenance of the networks.	Procurement team, Risk & Resilience team, Environment Team Mar-2027	Work with Procurement team and suppliers to identify those at particular risk of climate change. Consider all climate-related risks. Adaptation response required for climate change risk on BCM plans.
ARG19	Consider the wider risks to infrastructure networks (energy, water, transport, ICT) from cascading failures	Cascading Failures from storm events, heavy rainfall and erosion and similar. There may be opportunities identified as well as risks.	Environment team Mar-2026	Number of forums/ meetings attended on interdependencies and cascading failures with external organisations. Any shared actions, learnings or opportunities.
ARG23	Create a programme to assess and where required upsize/ replace/repair broken, and undersized field drains within SGNs network.	Some field drains are easily blocked due to increased rainfall. Culvert and field drain wash-ins.	Asset Management team Mar-2031 *(End of GD3)*	Drains have been repaired and/or upsized when identified preventing future risk. Assessment could be carried out on higher risk areas.

Findings

Inherently the gas networks are reasonably resistant to extremes of heat and cold and to wind due to a large proportion of our assets being underground or lower structures close to the ground. However, we are already seeing the impact of climate change on our network, particularly the increase in the likelihood of pipeline washouts in our Scotland network due to heavy rainfall and storms. At the time of report writing there were 108 washouts in Scotland and 1 in southern, the Scottish breakdown is included in table 5 below.

Table 5: Remediation totals in Scotland

Remediation Figures	No of Sites
Washouts Remediated	19
Washout Remediation Started	2
Exposures Outstanding	10
Bank Erosion Outstanding	77

For this reason, the two highest scoring risks are risk to underground pipelines from river erosion/flow and damage to above ground assets from storm events. These two risks are closely linked and there are a number of other cascading risks such as when storm damage affects ICT communications on site or when lightning damages a tree and it falls onto our assets.

Though flooding of below ground assets is high risk it is a low probability event. Above ground assets are less susceptible to flooding as assets are gas-tight. When flooding does occur on operational sites such as gas governors, we look at measures to remediate the risk such as raising the height of the site or relocating it. When water ingress occurs in below ground assets including pipelines, the water is harder to remove and can cause more significant damage. Water in pipelines can occur due to damage to water pipes as well as heavy rainfall and it tends to be a larger issue in winter. It requires us to use a syphon tanker or pump to extract the water from the main before disposing of it.

SGN have developed measures to maintain functional delivery in the face of climate impacts. These measures are shown as activities that we have recently implemented, that are soon to be implemented and those that are required over the longer term. These proposals are subject to funding from Ofgem as part of the RIIO-GD3 business planning process and are further detailed in our Climate resilience strategy which can be found on our website.

Recently implemented

Throughout GD2, we have experienced heightened volumes of climate related issues relating to pipes or pipe-supporting structures that cross rivers. Riverbank erosion has removed supporting ground, exposing pipes to the force of the river itself, exposed pipes to potential damage from debris being washed down the river and exposed traditional pipe protection measures (cathodic protection schemes, protective coatings, protective barriers) to river conditions that could be beyond their design parameters. In addition, pipe bridges or similar supporting structures, are also being eroded or damaged by flood waters.

We continue to gather information relating to above and below-ground crossings through our survey programmes as per our existing management procedures. These surveys involve recording and gathering information relating to our main and the site conditions as part of our continuing efforts to monitor and manage this risk. We aim to proactively identify locations of suspected coastal or river erosion to work with relevant stakeholders to agree on preventative measures to protect our pipelines and the environment.

The surveys often highlight the issue and allow us to prioritise mitigation measures dependant on risk. We have recently remediated 19 pipeline washouts and two of these examples are shown in Appendix A.3:

- Case Study A: Risk due to precipitation. This was a pipeline washout at Dighty Burn, St Monifeith, Scotland. It involved rock dumping and engagement with the relevant stakeholders to remediate washout and reduce flow rate around the affected pipe.
- Case study B: Risk due to precipitation: Pipeline washout – Brechin, Angus in Scotland. This involved large scale remediation in the form of coastal defence boulders and large drainage pipes to remediate future risk.

For some other washouts we have relocated the pipeline away from the river or burn where possible.

Soon to be implemented (i.e. by 2030)

We have carried out a review of how we assess our under-river crossings <7barg. We currently inspect these crossings as Table 6 below:

Table 6: Survey intervals

	Depth of cover (m)			
	≤0.5	>0.5 ≤ 1.1	>1.1 ≤ 4	>4
	Survey interval (years)			
Major water course (tidal)	1	1	1	1
Major water course (navigable)	2	3	5	15
Minor water course	5	5	5	Not required
Other water course (generally wadeable)	During external condition monitoring or close interval protection survey of the pipeline. Additional inspections where the local situation requires.			

We are proposing to change this in response to the emerging threats to our assets. This approach would enable us to be more proactive in understanding when a pipeline river crossing could become an issue so we can address the issue before it becomes a hazard. To ensure our networks remain safe and resilient over time, we are proposing that every crossing would receive at least one survey per year for the foreseeable future, i.e. starting in GD3 (2026-2031) and continuing beyond.

There are a number of projects planned in the near future, but we have a clearer understanding of our planned projects up to March 2026 as this regulatory period with OFGEM already has agreed budgets. There may also be some reactive projects if further climate-related incidents happen. For the period up to March 2031 we have submitted our business plan to OFGEM for approval, so any projects between 2026 and 2031 are subject to funding being granted.

An example of a pipeline diversion project soon to be completed is Forestmill in Clackmannanshire, Scotland. In 2020 a section of 60m section of 69 bar pipeline was washed out after flash flooding caused the river to burst its banks. At the time a temporary replacement of the pipeline was carried out, but a longer-term replacement route was planned by working with a third-party flood risk assessment. The major project at Forestmill is now at detailed planning stage and it is planned to be completed in 2025. We have received funding for this through the GD2 Diversions Reopener.

Figure 3 shows the exposed pipeline at Forestmill at the time of the original incident.

Figure 3: Pipeline washout at Forestmill, Scotland 2020

Required longer term (beyond 2030)

We will develop a long-term Asset Management Strategy up to 2050. Through this process we will consider climate risks over the long term, and how these could impact our network assets on a detailed level. It will allow us to assess options and determine what the most appropriate course of action is for a particular climate-related event. For example, this would consider whether mitigation or adaptation is the best approach, what project to invest in, including consideration of nature-based solutions, and how we can improve our response to reduce the impact of an event in the future. Part of the work will also be to identify suitable KPIs to measure the network's ability to withstand and recover from climate-related disruptions. By establishing a baseline, we can monitor our progress on how we are improving resilience.

We will also continue to work collaboratively with other GDNs and DNOs through the Climate Change Adaptation & Resilience Working Group, at the Energy Network Association, to ensure that the metrics and KPIs for monitoring and managing climate resilience are aligned, and to adopt an industry wide approach to these challenges. The future of heat decision to be made by the government in 2026 will affect the decisions we have for longer term asset replacements beyond 2050.

Interdependencies

The Energy networks are aware of the high-level relationship of decreasing gas supplies leading to an increase in electricity demand but there are also various other interdependencies we need to consider.

Telecommunications are essential to the operational sites to allow our Gas Control department to monitor the sites remotely. The telecommunication networks are increasingly reliant on an electricity supply, though many sites have battery backup or on-site generators in the event of temporary power failure. Cyber and communication interdependencies threaten the whole industry, impacting coordination and security, and hostile actor interference can impact every part of the network from loss of control of the network.

Cascading interdependencies beyond operations include increased storm frequency and flooding impacting transportation links affecting gas repair and restoration due to reduced accessibility. Current collaboration has been focused on gas and electricity transmission and distribution companies through the ENA Climate Change Resilience Group. We have also been involved in some regional climate adaptation planning, particularly in

Scotland with Climate Ready Clyde, Climate Ready South East Scotland and the Climate Ready Infrastructure Forum. We have been involved in Climate workshops in Scotland to focus on key interdependencies and what the risks may be from those, other participating stakeholders in these workshops included local authorities, Transport for Scotland, Scottish Power, and Scottish Water etc. At a recent Infrastructure and Business risks workshop with Climate Ready South East Scotland run by Sniffer in December 2024 the key priority risks raised were as listed below:

- risks to infrastructure networks (energy, water, transport, ICT) from cascading failures
- risks to infrastructure services from river, surface water and groundwater flooding
- risks to business from disruption to supply chains and distribution networks.

These priority risks identified by the group were also priorities and common risks for SGN, so it was useful to hear insights from the other stakeholders.

More work needs to be done in this area to understand shared risks and to identify opportunities for more collaborative working with the wider regions. In our southern network the Director of Operations attends industry group meetings to collaborate with the Mayor of London on developments in street works and sustainability initiatives, including sustainable urban drainage solutions to alleviate surface flooding in problem areas.

We will share any key points and learnings with the other main stakeholders, particularly the other GDNs via our long-established working group and also with the DNOs via the ENA Climate Change Adaptation group. Outside the sector we also have the opportunity to share and discuss key points in the various climate adaptation groups we are involved in, as well as through the Supply Chain Sustainability School's various leadership groups which we are a partner of.

Risk ARG19 and the corresponding action discusses interdependencies, particularly with the electricity and ICT sector and how we need to understand those risks and work together to mitigate any cascading failures. Working with external climate experts like Sniffer via forums including Climate Ready South East Scotland and Climate Ready Clyde helps, as they work independently to assess the climate risks for the region and work with the stakeholders and businesses to come up with action plans and prioritise risks.

Outlook

Based on our current assessment, the key climate risks to SGN are:

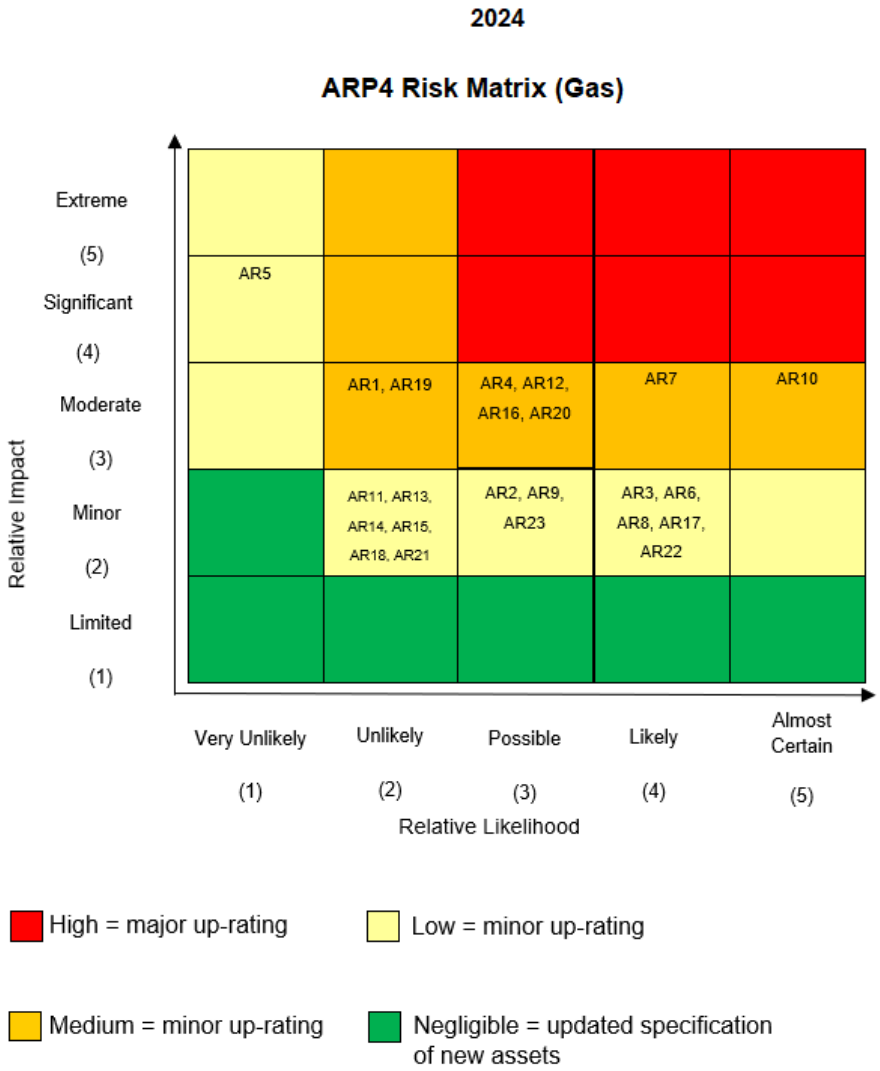
- Risk due to precipitation including storm events: Flood risk to above ground assets and risk to underground pipelines from river erosion and flow; and erosion at river crossings. This is the climate risk which we have seen the highest evidence of to date, illustrated by the case studies.
- Risk due to extreme high temperatures or drought: This can cause ground movement due to drought conditions and dry ground (potentially). This is an emerging risk and something which we are working to understand better. The impact would mainly be on areas which have not been part of our mains replacement programme (where old metallic mains are replaced with poly-ethylene pipe, known as PE pipe).
- Risk due to extreme low temperatures: During prolonged cold spells when there is extra pressure on our networks to keep customers warm, a combination of compound events exacerbated by climate hazards can lead to challenges meeting our emergency standard.

Our understanding of climate-related risks is still evolving and as is shown in the Climate Resilience Strategy we are making commitments to improve this over the coming years and into the next price control GD3 which runs from April 2026 to March 2031. We will continue to work on identifying and mitigating climate risks and adapting to climate change as much as possible. Currently the risks are well controlled up to 2050, beyond 2050 there is less certainty around the future of heat and the wider gas networks, but more will be understood after the governments heat policy decision in 2026.

Appendices

A.1 Adaptation Reporting Power (ARP4) - Risk Matrix

This risk matrix shows the relative impact and likelihood behind the risk scores in Table 2 and in Appendix A.2. The ARG placement shows where each risk sits within the overall matrix. This has been developed from the ENA collaborative risk matrix to show the SGN specific scoring.



A.2 Risk scores with no change since ARP3

Risk Code	Risk	Description	ARP3 Risk Score	Mitigation Progress	ARP4 Risk Score
Temperature					
ARG6	Above ground assets affected by raised temperatures	Gas equipment is inherently resilient and designed to operate at high temperatures as network assets are manufactured to international standards. Where temperatures increase above designated temperature parameters, the impact to network controls should be minimal.	**8**	Gas network assets are manufactured to international standards and designed to operate within particular temperature parameters, which include those currently experienced in the UK and the expected potential (chronic and acute) increases over the course of the century. Increasing temperature are more likely to affect ancillary IT and telecommunications equipment.	**8**
Precipitation					
ARG4	Flood risk of above ground assets	Assets in flood plains (fluvial) or otherwise are physically vulnerable to extreme and extended rainfall (pluvial). Ancillary instrumentation and communication equipment are notably the most vulnerable, despite governors and pressure-reducing equipment being resilient and capable of operating when submerged in water. Vulnerability exacerbates if flood defences are ineffective and/or plant relocation is not possible.	**9**	Frequency and intensity of flooding events is likely to increase in future. Most impact is limited to those assets (and downstream customers) close to watercourses. Flood risk assessment has identified small numbers of above ground asset sites which are at risk of significant inundation and not protected by public flood defences. Core mechanical gas assets have high degree of integral resilience to flood impacts. High risk assets at identified risk of flooding have been proactively relocated or have vulnerable equipment raised off the ground.	**9**
ARG5	Flood risk of above ground assets from catastrophic dam failure	Extreme precipitation can lead to dam overload and failure. 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.	**4**	Many GDNs are not of particular risk to dam failure. GDNs who are vulnerable assess all vulnerable assets in their network. The number and type of assets in the proximity to reservoir flooding have been identified using two scenarios, dry day and wet day.	**4**

ARG9	Asset impact from snow/ice falls and accumulation	The risk to above ground assets is expected to gradually decrease due to less frequent snow events. However, a risk remains of physical damage from excessive snow or ice falls, for example, increased loading on building roofs.	6	The score remains the same, though the climate data suggests warmer winters the likelihood still remains as possible and the impact minor. Gas assets are designed to high degrees of resilience which is likely to be sufficient to cover demand in future cold snaps, especially if gas customer numbers reduce as forecasted.	6
ARG22	Ground water flooding of below ground assets leading to water ingress to pipes	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.	**8**	Impacts are typically observed in low pressure network and can be managed via typical operational practices e.g. syphon tanker. Groundwater flooding can also result in increased pipeline buoyancy thereby exerting additional stresses on pipelines increasing the potential for damage. Increased buoyancy can also increase the likelihood of third-party damage to pipelines due to reduced depths of cover.	**8**
Temperature and Precipitation					
ARG15	Vegetation Growth	Increases in temperature and precipitation will lead to increased vegetation growth. Above ground assets will be impacted by any increased growth of trees adjacent to operational equipment, leading to increased maintenance and reduced accessibility. Similar issues may be encountered with the accelerated growth of plants or invasive species.	**4**	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. 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.	**4**
Other					
ARG20	Tidal flooding of above ground assets	Regardless of the source the impact of flooding on above ground assets is the same. There is a risk of physical damage to assets, although governors and pressure reducing equipment are 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.	**9**	For new and replacement above ground installations and pressure regulating installations, vulnerability to flooding (and other natural events) is reviewed and a flood risk assessment is carried out. Tidal flooding incidents would also be raised at our Condition Review group to consider if any other mitigation is required.	**9**

ARG21	Saline contamination and increased corrosion rate of above and below ground assets from sea water	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.	**4**	Impacts are mitigated by the use of cathodic protection and proactive pipeline inspection programme. No known significant impacts to date. Where the groundwater has a high level of saline contamination this will result in a change in Cathodic Protection readings which will be addressed through maintenance, if necessary altering the frequency.	**4**
Environmental Management					
ARG16	Wildlife impacts	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 digging etc.	**9**	Any changes 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 are regularly reviewed.	**9**
ARG18	Precipitation - BCM plans affected due to severe travel difficulties resulting from extreme weather events	Business Continuity Management plans could be affected due to extreme weather events. There may be an impact on organisational capability and staff resources and the continued operation and maintenance of the networks.	**4**	Risk to travel and associated operational difficulties due to weather events are covered in our BCM Plans. The COVID pandemic has tested the arrangements and systems in place which have proven to be effective**.**	**4**
ARG19	Knock on effect on GDN operations from variable electricity supply due to impact on DNOs	One of the potential interdependencies within the energy sector is the knock-on effect on gas network operations from a variable electricity supply. Any initial climate impact on the electricity networks may result in electricity supply interruptions leading to an impact on asset operations and gas supplies to customers.	**6**	This risk requires a utility response and collaboration and is noted as an interdependency. To ensure resilience across our Property portfolio we have one depot per sub-region with additional power supply. CNI3 assets (large offtakes etc) have alternative power supply (onsite generators). Gas control & the Operations Control Centre also have alternative power supply.	**6**

[3] Critical National Infrastructure

A.3 Case Studies

As we have experienced several climate-related incidents to our networks, we are sharing two case studies here for information.

Case Study A: Risk due to precipitation: Pipeline washout Dighty Burn, St Monifeith, Scotland

In 2019, as part of a survey for the Inspection and Maintenance of Above Ground (≤7 Barg) Pipe Crossings, it was identified that approximately 50 metres of the riverbank on the River Dighty in Monifieth, Scotland had been washed away, exposing approximately 3m of an intermediate pressure (IP) pipe crossing the river, as shown in figure 4.

Figure 4: Exposed section of IP pipe crossing River Dighty

- The effect of the river on the exposed section of pipe was to strip approximately a 3m section of the protective coating.
- The IP pipe is part of SGN Grid 13 Perth Dundee IP/MP system. Failure of this pipe would result in the loss of gas to approximately 25,000 customers.
- Multiple remediation options for the pipe were considered, including replacing the pipeline, however due to the topography this was ultimately deemed impractical. It was decided the best course of action was to build a temporary water break to facilitate repairs to the protective coating of the pipe. The integrity of the pipe was then protected by rock dumping to re-establish the riverbed, figure 5.

Figure 5: Stages of rock dumping to remediate washout.

- Following engagement with the river authorities, the riverbank was re-established and reinforced to provide long-term protection for the pipeline without disrupting the natural course of the river.

Case study B: Risk due to precipitation: Pipeline washout – Brechin, Angus in Scotland

This case study discusses the impact of a weather event on our assets in Brechin in 2023. Storm Babet brought exceptional rainfall to parts of eastern Scotland with 150 to 200mm falling in the wettest areas and the Met Office issued two red warnings for rain. For the county of Angus - inside this red warning area - 19 October 2023 was, by a wide margin, the wettest day on record since 1891.

During Storm Babet a 250mm intermediate pressure (IP) steel main was washed out near Brechin in Angus, in our Scotland network and the main was exposed for 40 metres. The pipeline is the sole feed to approximately 10,000 customers. The volume of farmland washed away was 145,000 m3, which equates to 218,000 tonnes of soil. The entire area became a flood plain as is shown in figure 6.

Figure 6: Satellite photo of the impact from heavy rainfall during storm Babet which caused a pipeline washout near River South Esk, Brechin

Schematic 1 – River South Esk at Brechin in 2022.

Schematic 2 – River South Esk at Brechin in 2024. Satellite imagery shows the impact of Storm Babet at the be where the riverbank protection (and foliage) has been washed away.

We had to make the pipe safe and re-protect it in that area. From what we could see from the landscape, to recover it with the surrounding earth would not have been enough should another flood occur. Due to the lay of the land, the water channelled into the area with enough force to propel full trees towards our pipe, creating a high risk of damage and potentially even rupturing our pipe. The remediation we undertook therefore was the best approach to protect our pipe whilst allowing the flood water to navigate through the area should a similar flood happen again.

For the remediation we took a tonne of gravel bags and covered the line securing these with rip rap boulders (commonly used for costal defence). Then we installed 600mm drainage pipes to allow future flood water to pass through the remediation works. We covered this structure with further local gravel to give a final layer of protection. We invested £140,198 (CAPEX) to protect our pipe from future floods.

If the 250mm main had failed it would have resulted in the loss of supply to approximately 10,000 customers. This would have cost SGN approximately £14,000,000. Removing water from gas mains is a very hard and costly process. The reason it would be so costly is because any break under the flood would have caused the downstream system to flood.

Based on events in our Scotland network, analysis has been carried out for river crossings that fall within a storm path that have led to excessive river flows in our Southern network. Currently those sites are being surveyed and when complete these surveys will determine if remediation work is required.