Climate Change Adaptation Report (ARP4)

National Grid Venutres

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nationalgrid

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Executive Summary

National Grid Ventures (NGV) have not previously submitted a response to DEFRA's Climate Change Adaptation Reporting Power (ARP) cycles. After identifying this gap and reviewing the benefits which National Grid Electricity Transmission (NGET) have realised through several cycles of reporting, NGV have incorporated this into their reporting and governance model. Furthermore, NGV acknowledges DEFRA's request for National Grid's non-regulated assets to report as per the regulated businesses. This report therefore fulfils NGV's commitment to the fourth-round reporting cycle (ARP4) as a new reporting organisation.

This report determines that it will be necessary for NGV to continually appraise its understanding of climate risk and the potential scale and timing of impacts on its assets. This will be through a range of measures including climate modelling, risk assessment, process development and engagement with external stakeholder and policy makers. These have been captured via adaptation plans in line with ISO 14090.

While 2050 is a key date in climate policy, this report demonstrates that action is needed now and consistently during the coming decades. Inaction will only result in a loss of resilience and the opportunity to implement satisfactory solutions, particularly where risk assessment, investment planning and (where needed) construction might take many years.

As a new reporting organisation, NGV have developed a collection of climate change risk assessments, identifying the climate risks that could affect our ability to deliver our functions and objectives. These risk assessments have been developed in conjunction with National Grid Group's internal Climate Change Risk Tool (CCRT) which overlays leading climate models with our assets.
The risks identified have been presented as part of the wider Group project but have also been articulated directly to NGV's SHE committee as NGV aims to further integrate climate risk management into governance.

In alignment with the energy sectors CCRA3 risks, the high and medium climate risks identified are as followed:

- Coastal Flooding (I3)
- River Flooding (I2)
- High Winds (I10)
- Compound Events (I10)
- High Temperatures (I10)
- Heatwaves (I10)

Finally, given the risks identified within the report as well as the interdependent and cascading risks noted, it is key that NGV work across the industry and with wider network groups to implement adaptation measures in a co-ordinated, collaborative manner.

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National Grid Ventures

NGV operates in the competitive transition infrastructure space in the US and UK where it develops, operates, and invests in energy projects, technologies, and partnerships to accelerate the development of a clean energy future.

We want to bring energy to life and be at the heart of a clean, fair and affordable energy future. We do this by doing the right thing, finding a better way and making it happen.

We've developed a portfolio of diverse and complementary businesses, each of which makes a vital contribution towards the twin goals of ensuring security of supply today and developing the clean energy solutions of tomorrow. Throughout all of this, we have always remained true to our commitment to be a responsible business that does the right thing.

NGV runs separately from National Grid plc's core regulated operations. Our diverse businesses include subsea electricity interconnectors, wind and solar power generation, competitive electricity transmission, battery storage, conventional generation as well as LNG regasification and storage. We're also developing emerging technologies such as Offshore Hybrid Assets (OHAs) which could play a key role in decarbonisation. For this report, we shall focus on our 2 UK-based operational business areas; Grain LNG and Interconnectors.

Grain LNG

Grain LNG is of strategic national importance to UK energy infrastructure and security of supply. Grain is the largest LNG terminal in Europe and eighth largest in the world by tank capacity with a site that spans over 600 acres in total. This scale enables Grain to process LNG shipments from a broad mix of global supply sources. Grain currently provides 40% of the UK's LNG import capacity and has the capacity to store and transmit 25% of the UK's average annual gas requirements (15% during winter peak demand).

Invested so far	UK Capacity Grain LNG can deliver	Meters cubed tank space
1.1BN	**20%**	**1M**
Acre site	Cryogenic lines & jetties (QMAX)	Experience in the LNG Industry
+600	**2**	**+30 year**

Figure 1 – Grain LNG's headline figures as of December 2024

Grain LNG is currently expanding its storage capacity which will soon reach 1,200,000 m^3 in 2025 as part of a 25-year capacity contract with Qatar Trading Ltd. This is vital for the energy transition as it is believed that by 2030, ~70% of the UK's gas will be imported.

Grain LNG is committed to protecting the environment for future generations and supporting their energy needs through being an innovative, socially responsible business.

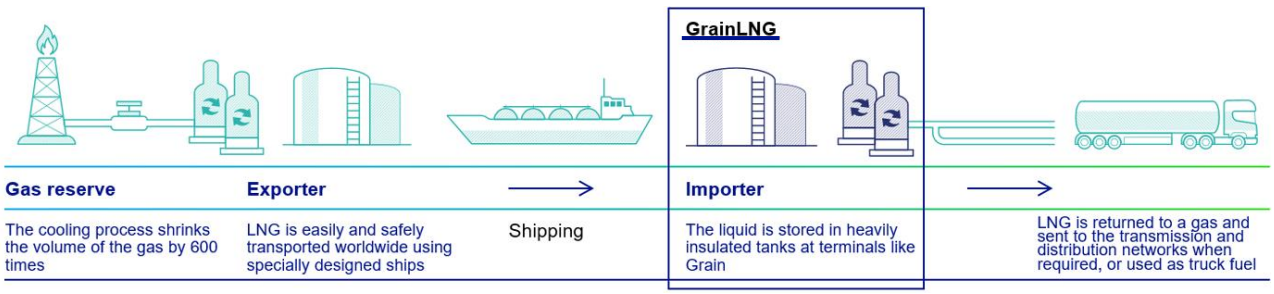

Figure 2 – Role of Grain LNG within the wider LNG industry

Interconnectors

Interconnectors are high voltage cables that are used to connect the electricity systems of neighbouring countries. They enable the trade of excess power, such as renewable energy created by the sun, wind and water, between different countries.

In 2022, National Grid's interconnectors supplied 4.8% (13.7 TWh) of total electricity consumption in Great Britain. Approximately 70% of this energy came from zero-carbon sources.

Now, in 2024, NGV are operating six interconnectors, exchanging 7.8GW of power between Great Britain and Europe. This is enough to supply 15% of our country's electricity requirements. By 2030, 90% of the energy imported by our interconnectors will be from zero carbon energy sources.

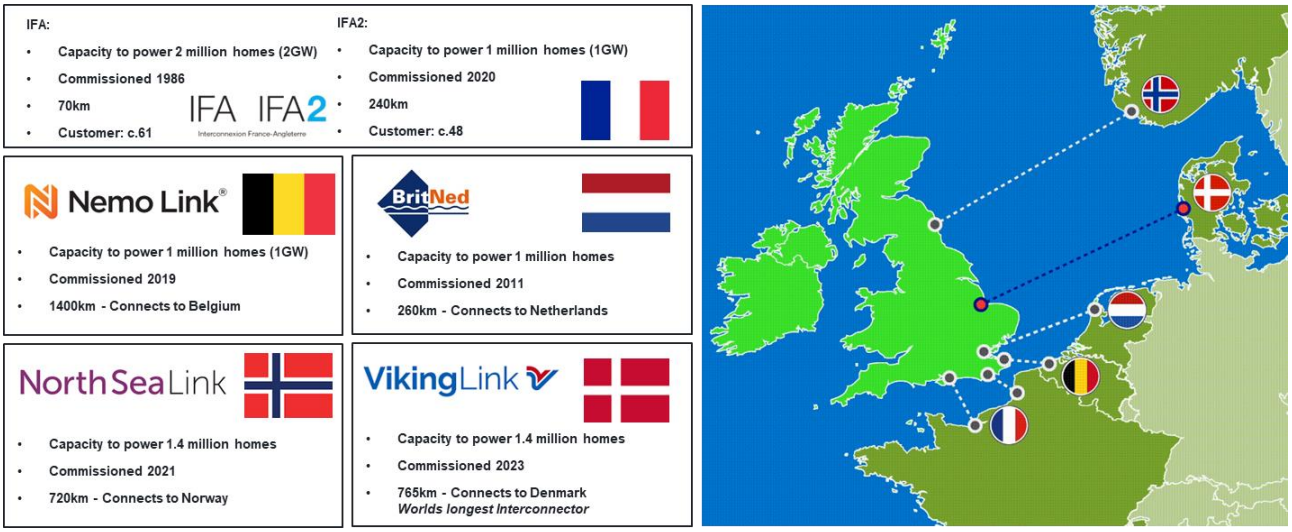

Figure 3 – NGV Interconnectors in operation

Within this report, we have only considered NGV's unincorporated joint ventures (UJVs). NGV's Interconnectors which fall under an incorporated joint venture (IJV) are therefore excluded (BritNed and Nemo Link).

Governance, Management and Strategy

Climate adaption and mitigation activities to address NGV's physical risks are embedded into National Grid's core business processes through defined Group Principal Risks (GPRs).
For the climate change GPR there are two distinct elements:

1. Climate Change (mitigation GPR): The standalone mitigation risk is aligned to our strategic objective 'Enable the energy transition for all', with a focus on delivering clean, decarbonised energy to meet our net zero goals.
2. Significant Disruption of Energy (adaptation GPR): The adaptation, or physical risk activity, absorbed within the control framework associated with the 'Significant Disruption of Energy' risk, has helped ensure National Grid continue to deliver energy reliably for our customers, with a focus on resilience.

The above allows for greater oversight, focus and adoption of two distinct and proportionate control frameworks in line with the National Grid Group risk appetite – mitigating downside risk, and maximising opportunities, where applicable.

Using these frameworks, the key climate change adaptation controls identified include the following:

- Fit for Future of Electricity Strategy: A corporate strategy that considers the steps to ensure our business remains resilient in the future, such as enhancing design standards and investments on asset hardening and flood protection.
- Engineers Governance Forums: Group Chief Engineer and engineering duty holders sharing guidance and data on key topics such as resilience.

- Resilience and Asset Management Business Management Standard (BMS): Sets out minimum requirements and a framework for resilience capability and managing asset risk to ensure each business unit is prepared for the next disruptive event.
- Establishment of the Business Resilience and Crisis Management Organisation: Reporting to the Group Chief Risk Officer and Group Legal, this team is focused on building resilience to all threats and hazards. This includes the development of crisis management and business continuity plans, training, and exercises to help align and coordinate our response to severe weather and other crisis events; but is also leveraging innovative technologies to improve our intelligence, looking strategically at evolving risks associated with climate change. We are also expanding our network of external stakeholders to identify and leverage industry thought leadership and play an active role in shaping new policies and regulations.

Supporting the above, National Grid's Responsible Business Charter (RBC) sets a clear direction and acknowledges the increasing frequency and intensity of climate-related hazards which will affect our business.

Using this group structure as a foundation, and through the development of an internal Climate Change Risk Tool (CCRT), NGV has taken accountability for its business units through the creation of climate vulnerability assessments and adaptation plans. These assessments are tracked, updated and discussed on an annual basis within the NGV SHE Committee. This is overseen by the NGV Environment & Sustainability (E&S) team who are able to communicate these assessments alongside NGV's principle risks, therefore identifying opportunities to increase our resilience and improve environmental performance.
This is an ongoing process which is incorporated in to NGV's risk management process, allowing NGV to push climate change adaptation objectives within NGV's wider strategy and ensure that we are resilient in the face of more extreme and frequent weather events.

This allows for top management to monitor ongoing climate change scenarios to assess whether the risks identified within the completed assessments are increasing and warrant further mitigating action dependant on the risk appetite.

NGV are also constantly reviewing adaptation guidance to embed best practice within the business wherever applicable. This is supported by National Grid's Chief Sustainability Office (CSO) and Chief Engineer and Risk Office (CERO).

Understanding Risks and Challenges

As noted above, a group-wide Climate Vulnerability Assessment (CVA) was undertaken towards the end of 2023. This provided a systematic and multi-decade understanding of NGV's asset vulnerability to climate change and laid the foundation for optimised resilience plans.

The climate risks were developed through a simple model to ensure the assets with the highest vulnerability, greatest exposure, and highest likelihood of hazard impacts were identified. A simple risk model is the foundation of this assessment:

The climate scenarios used in the CVA are based on greenhouse gas concentration trajectories adopted by the Intergovernmental Panel on Climate Change (IPCC) in AR5. The trajectories are known as 'Representative Concentration Pathways' or RCPs. RCPs provide a uniform framework to understand the impacts of potential climate changes. The RCP scenarios reflect global climate models (CMIPs) as well as varying levels of emission reductions and climate policy adoption including the adoption of renewable fuels and technologies. CMIP5 - the fifth phase of the Coupled Model Intercomparison Project - is used in this analysis. Because there is a level of uncertainty in all pathways and as climate modelling continuously evolves, RCP8.5 was mainly used to indicate a worst-case scenario. RCP8.5 refers to the concentration of carbon that delivers global warming at an average of 8.5 watts per square meter across the planet. RCP8.5 estimates the highest predicated greenhouse gas concentrations and an estimated global mean surface temperature increase of 4.3°C by 2081-2100. This scenario is the 'high emissions scenario' and will ensure mitigation addresses the worst-case scenario modelling output. A more optimistic scenario, in which emissions are reduced compared to RCP8.5, would produce smaller projected increases in these hazards, such as that of RCP2.6 and 4.5 scenarios, which would represent closer to the 2°C global mean surface temperature increase. These projections represent what the climate could look like if the Paris climate agreement goals are achieved.

It's assumed in all UKCP18 scenarios that projections will remain similar up until 2050 regardless of emission reductions. Only post 2050 do RCP scenarios and climate projections begin to differ with greater uncertainties. For this reason, we will use RCP4.5 projections to make assessments until 2050, then use both RCP4.5 and RCP8.5 emission scenarios thereafter. Splitting our assessment in this way will highlight any periods of key change which may present risk to NGV assets.

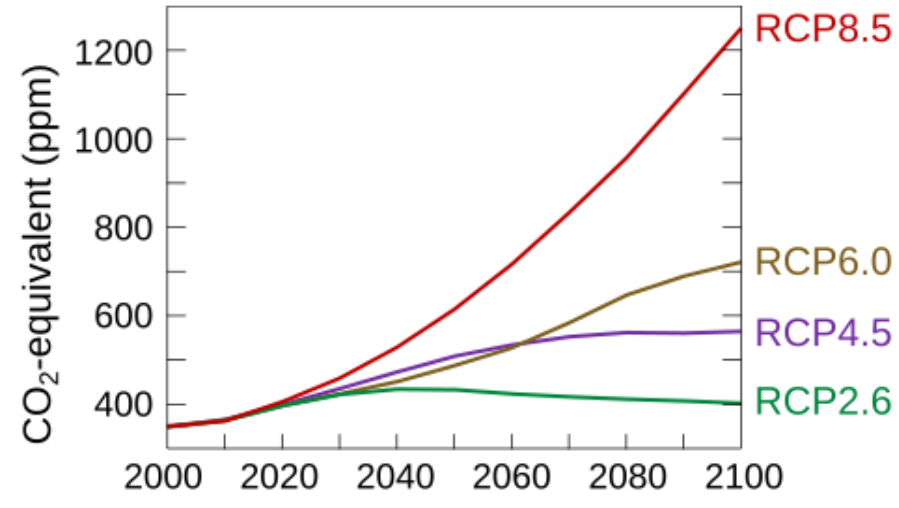

Figure 4 -IPCC Representative Concentration Pathways

Definitions

Definitions of the climate hazards used within the CVA and above risk assessments can be found within the below table.

Climate Hazard	Definition	Threshold
Coastal Flooding	Frequency of occurrence of coastal flooding and future impacts due to sea level rise	N/A
River Flooding	Frequency of occurrence of river flooding and future impacts due to increase in extreme rainfall precipitation (one day maximum precipitation)	N/A for current climate, to estimate increase in frequency of flood events days over 25 mm (1 inch) precipitation has been used as threshold
High Temperatures	Number of days per year when maximum daily temperature is above the threshold	Days above 30 °C (86 °F)
Low Temperatures	Number of days per year when maximum daily temperatures is below the threshold	Days below 0 °C (32 °F)
Heatwave	Number of times per year when both maximum and minimum daily temperature remain above thresholds for several days	Maximum daily temperature above 30 °C and minimum daily temperature above 20 °C for 3 consecutive days
High Winds	Number of days per year when maximum daily wind gusts are above the threshold	Maximum daily wind gusts above 25 m/s (~60 mph) and precipitation over 25mm (1 inch) in the same day. Extracted for summer and winter seasons.
Compound Events	Number of days per year when both high winds and high precipitation are above the respective thresholds	Maximum daily temperatures above 0 °C and minimum daily temperature below 0 °C in the same day

Interconnectors

Risk Code	Climate Variable	Risk score Present day scenario	Risk score mid-century scenario	Risk score end of century (+2°C) scenario	Risk score end of century (+4°C) scenario
I3	Coastal Flooding	Med	Med	Med	Med
I2	River Flooding	Med	Med	Med	Med
I10	High winds	Low	Low	Low	Low
I10	Compound events - Summer	Low	Low	Low	Low
I10	Compound events - Winter	Low	Low	Low	Low
I10	High temperature	Low	Med	Med	Med
I10	Heatwaves	Low	Med	Med	Med

Across our Interconnectors there are 2 key areas of risk: flood and warm weather hazards.

Flood Hazards

Regardless of the source, the impact of flooding on NGV's Interconnectors is the same. Electrical assets and supporting systems can be physically damaged by flood water and water ingress can cause assets to fail, leading to extensive loss of supply. The consequential repair or replacement of assets is costly, time-consuming, and extends restoration times. Flooding also poses other risks such as landslips which can expose and damage underground assets.
The risk of flooding to our Interconnectors includes equipment submersion causing electrical failure, accelerated corrosion and increased contamination risks. Flood risk assessments have been undertaken at each of our Interconnectors, each of which having a different level of flood risk, therefore an average risk has been chosen for the risk assessment above.

Warm Weather Hazards

High temperatures have been identified as a key hazard as they impact our Interconnectors through reduction in the performance and efficiency of assets. Whilst many asset components are generally rated to withstand temperatures greater than those experienced in the UK today and future scenarios, there is a risk of increased failures, exceedances of design standards and reduction in performance during heat events and increased average temperatures. For our Interconnectors this includes exceedance of oil flashpoints and trip levels, electrical failure and flash over, reduction of asset lifespan and increased risk of run back.

Grain LNG

Risk Code	Climate Variable	Risk score Present day scenario	Risk score mid-century scenario	Risk score end of century (+2°C) scenario	Risk score end of century (+4°C) scenario
I3	Coastal Flooding	High	High	High	High
I2	River Flooding	High	High	High	High
I10	High winds	Low	Med	Med	Med
I10	Compound events - Summer	Low	Med	Med	Med
I10	Compound events - Winter	Low	Med	Med	Med
I10	High temperature	Low	Low	Low	Low
I10	Heatwaves	Low	Low	Low	Low

Due to the geographic location of Grain LNG, the main risks observed are that due to coastal and river flooding. A number of Strategic Flood Risk Assessments have been undertaken at Grain LNG, therefore these risks are well understood and are being frequently reviewed.

Interdependent and cascading risks

Interdependencies between different industry sectors is a major source of risk for NGV's assets, with failures from one sector frequently causing impacts and potential cascading impacts to other sectors. Due to the interdependencies of different industry sectors such as gas, telecommunications, water and road networks, with the operation of NGV's assets, it is important to assess common climate change risks to prevent potential cascade events. If these networks are not equally resilient or adapted to climate change, this could undermine the effectiveness of NGV's own adaptation investments, leading to inefficiencies or failures.
It is also important to acknowledge that some of NGV's assets are protected by off-site non-NGV measures such as the Thames Barrier. To address the above and ensure all measures are captured, NGV will look to become embedded within wider industry working groups and discussions on climate resilience and adaptation.

Adaptation Action Plan and Implementation

Following the above, each business unit has created an adaptation plan for their highest climate risks noted above. In the short-medium term (by 2030), these plans mainly revolve around future research to improve our understanding of risks and the vulnerability of specific assets, what adaptive capacity is currently available and what future adaptation is required to further minimise these risks.

For the long term, works such as new or upgraded flood defences and increased HVAC capabilities have been identified to combat flood and heat hazards. These plans shall be reviewed on an annual basis in line with updated climate forecasts and any updated research materials. If works are required to be brought forward, the plans shall be revised and updated accordingly.

An example of one of these adaptation plans has been included below.

Hazard – High Air Temperatures and Heatwaves
Business Unit – NGV Interconnectors

Vulnerability	1. The risk of power failure and HVAC Failure will result in inaccessibility to critical operational/control sites or equipment overheating. 2. The risk of Run Back as ambient temperature exceeds design temperature of 35°C.
Adaptive Capacity	1. Temporary Supplies from Diesel Generators and other sources have been utilised in areas where the site supplies have failed. Temporary systems have limitations – CO_2 output, no alarms, no fire protection/detection and increased maintenance. Temporary HVAC hired-in to support failed installed HVAC systems (tripping hazards, fire doors forced open, no alarms of failure of temp systems) 2. No adaptive capacity for IFA2
Adaptation Plan	Ensure Future Interconnector specifications have A) triplication of power supplies for the auxiliary systems and B) full 100% redundancy of HVAC systems A) Review and audit each current site and or circuit for its Auxiliary Supply provision, where triplication of supplies is not part of the scheme, create an investment paper to ensure triplication of supplies is delivered. B) Review and audit each current site to the designed capacity of the HVAC system and review the 100% redundancy capacity of the HVAC system is attained. Investment scheme required if not C) Ensure Triplication and 100% redundancy is in the 'new' Interconnectors Specification D) Investigate requirements to allow Convertor Stations to run at higher temps (IFA2 35- 40°C)

Whilst this is ongoing, NGV has committed to regular emergency planning exercises where we robustly test our resilience to climatic hazards. The scenarios of which these exercises take place are drawn from realistic weather extremes taking real events and amplifying them, therefore enabling NGV to further understand risks and improve upon adaptation plans.

Next Steps

As evidenced though this report, NGV are committed to maintaining and improving the climate resilience of our assets. Noting the limitations of the work which has been completed to date, including the limitations of the internal CCRT, we aim to build on this by continuing to assess and investigate the identified hazards and risks, and establishing a roadmap to embed climate change resilience within NGV. Consideration will be given to how these adaptations can be aligned with business activities and investment plans in order to ensure cost effective solutions are implemented.

We will use innovation, data science and past experiences to further our knowledge, develop adaptation pathways and share our learnings across the industry and other sectors whilst remaining dynamic as climate adaptation evolves.

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