national gas transmission

Gas Ten Year Statement

December 2023

Welcome
How to use this document

We have published the Gas Ten Year Statement 2023 as an interactive document.

Home
This will take you to the home page.

Enlarge/reduce
Hover over the magnifying icon to make charts bigger or smaller.

Arrows
Click on the arrows to move backwards or forwards a page.

'Linked' content
Words in green and underlined have links to other pages in this document, or are URLs.

Welcome to this year's Gas Ten Year Statement

The energy sector is constantly evolving. Whether it's changes in the economic landscape, developments in technology, or changing consumer behaviour; there's a constant need to remain mindful of our energy needs today, tomorrow and in the future.

Whilst there is significant focus on today's energy infrastructure and markets due to the impacts the war in Ukraine has had on the security and cost of energy, it's important to look to (and prepare for) the future and the opportunities it might hold.

The Gas Ten Year Statement (GTYS) is published annually and aims to encourage and inform debate amongst our stakeholders and the wider industry, leading to changes that ensure a secure, sustainable and affordable energy future.

As the name suggests, this publication takes a look at the next ten years for Gas Transmission, explaining the investments and improvements we're making, and plan to make, to the National Transmission System (NTS) to ensure we can continue to provide a safe, secure network that meets the needs of our customers.

This year we have added a short section about the resilience of our assets, specifically the activities we will undertake to help us understand what network/asset changes are required to deliver the appropriate level of resilience to meet our regulatory obligations and our customers' needs.

We also share the progress and plans we're making for transitioning to net zero by 2050, in line with the commitment made by the UK government in 2019, and how any changes to legislation have impacted this.

Introduction

Introduction

Our role

We are the owner and operator of the gas NTS in Great Britain – our licence is established under the Gas Act 1986.

We are required to develop, maintain, and operate economic and efficient networks and to facilitate competition in the supply of gas in Great Britain. Our primary responsibility is to transport gas safely, efficiently and reliably across the NTS, managing the day-to-day operation of the network. This includes maintaining system pressures within safe operating limits, ensuring gas quality standards are met and acting as the residual balancer for supply and demand if there is a market imbalance.

As the System Operator, we are responsible for identifying the long-term needs of the network and our customers. As Transmission Owner, we make sure our assets are fit for purpose and safe to operate.

We are working closely with the Electricity System Operator (ESO) in establishing the roles and responsibilities of the Future System Operator (FSO) along with DESNZ and Ofgem. The creation of the FSO is an important step forward in the development and coordination of a whole energy system view in order to drive towards net zero in a safe, affordable and energy secure way that benefits everyone. It is essential that the FSO has a clear focus on energy security for the end consumer and that the energy networks are maintained and developed appropriately to provide the resilience required in an affordable way.

This statement sets out the challenges on the gas network now and into the future and provides our current view of the essential elements for development that should be undertaken to provide the required level of resilience, it is underpinned by stakeholder input from across the industry.

Our network

The NTS plays a vital role in the secure transportation of gas and the facilitation of a competitive gas market. It includes approximately 7,630 km of pipelines, presently operated at pressures of up to 94 bar (see appendix 3 for a detailed view of NTS maps).

Our network transports gas from entry terminals and storage facilities to exit points, where gas is transferred to four distribution networks (DNs) for onward transportation, or to directly connected customers such as storage sites, power stations and large industrial consumers.

The NTS also exports gas to Ireland and continental Europe via connecting pipelines referred to as interconnectors.

Our Network Development Process

One of our key aims for this publication is to make our investment decisions as transparent as possible by outlining the various stages of our Network Development Process (NDP).

The NDP defines and manages our project life-cycles from inception through to closure. The process defines our methodology for optioneering, developing, sanctioning, delivering and closing projects that address our Drivers of change.

The aim of this process is to deliver the best value, fit for purpose solutions for identified challenges or opportunities. The process also ensures we consider and meet the needs of regulatory/legislative requirements, our customers and our stakeholders, as well as our own.

The NDP is central to our planning activities and informs the work that we carry out on the NTS. We therefore structure this publication in line with this process, with chapters covering our drivers of change, network capability and options and development.

We also provide information on our transition to net zero and the work we are undertaking with methane emissions and hydrogen.

Figure 1
Our Network Development Process.

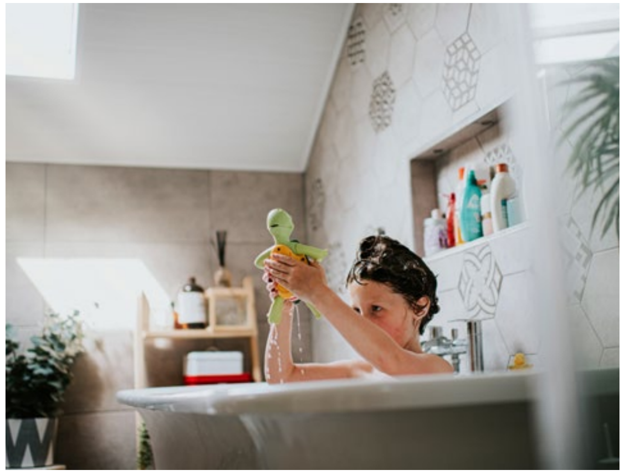
1 Drivers of change

1.1 Introduction

This chapter describes the drivers of change that can trigger stage 1 of our NDP (figure 2).

Figure 2
Drivers of change that can trigger our NDP (rollover the magnifying glass icon to find out more information).

Customers' immediate and future needs



Asset management

Legislative change

Net zero by 2050

1.2 Customer needs

1.2.1 Future supply/demand scenarios

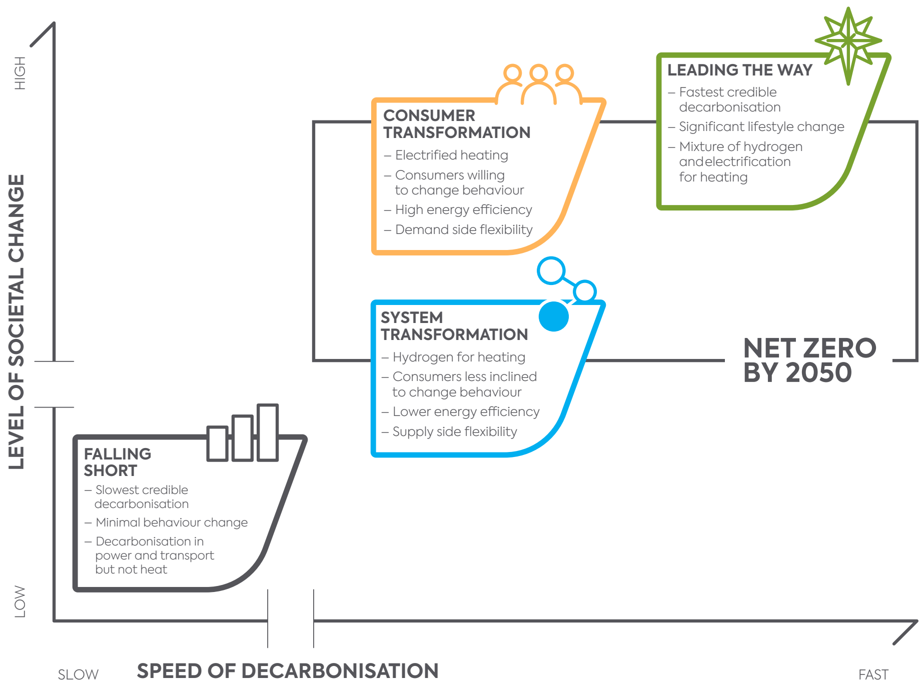
Our long-term customer needs are articulated within National Grid ESO's Future Energy Scenarios (FES), following extensive modelling, research and stakeholder engagement. We use the FES and other industry information, including our own Common Planning Pathway analysis, as the starting point for all our future network planning.

These scenarios and analysis provide a view of how much energy might be needed and where it could come from. They look at what the potential changes over this time period might mean for the industry and for its customers.

The high-level FES scenario framework has remained unchanged for 2023 FES.

GTYS uses the comparison between now and 2033 to highlight how key potential changes to gas supply and demand over the next decade could impact the gas transmission system.

Figure 3
The 2023 FES scenario framework.



1.2 Customer needs

1.2.2 Annual gas demand

Figure 4 shows how annual gas demand changes by scenario out to 2050. The 2022 and 2023 FES data is included to show how the FES scenarios have evolved. There was a significant demand increase last year. This was driven by the high exports to Europe due to reduced Russian gas flows to Europe. The FES has only had minor updates this year to reflect these changes. However, they do predict a further reduction in the Falling Short and System Transformation scenario with the Falling Short scenarios.

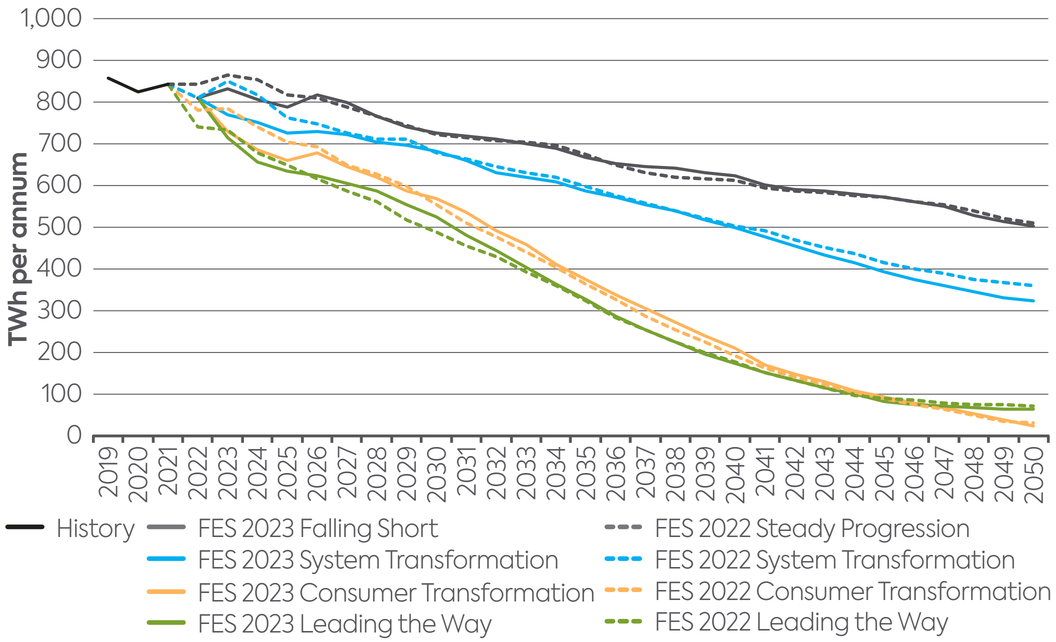
System Transformation requires the least societal change of the net zero scenarios. Hydrogen is favoured for decarbonisation.

Consumer Transformation sees high levels of societal change and a move to the electrification of heat.

Falling Short (previously Steady Progression) continues the current rate of change, has the slowest decarbonisation and is the only scenario that does not meet the 2050 net zero target.

Leading the Way assumes the highest levels of societal change to achieve the quickest and largest reduction in natural gas demand.

Figure 4
2022 FES and 2023 FES annual demand comparison.



1.2 Customer needs

1.2.3 Peak daily demand

Gas peak day (1-in-20) demand is illustrated in figure 5. As with the annual demand assessment, the 2022 and 2023 FES data is included to show that over the next 10 years there is little change in the predicted reductions.

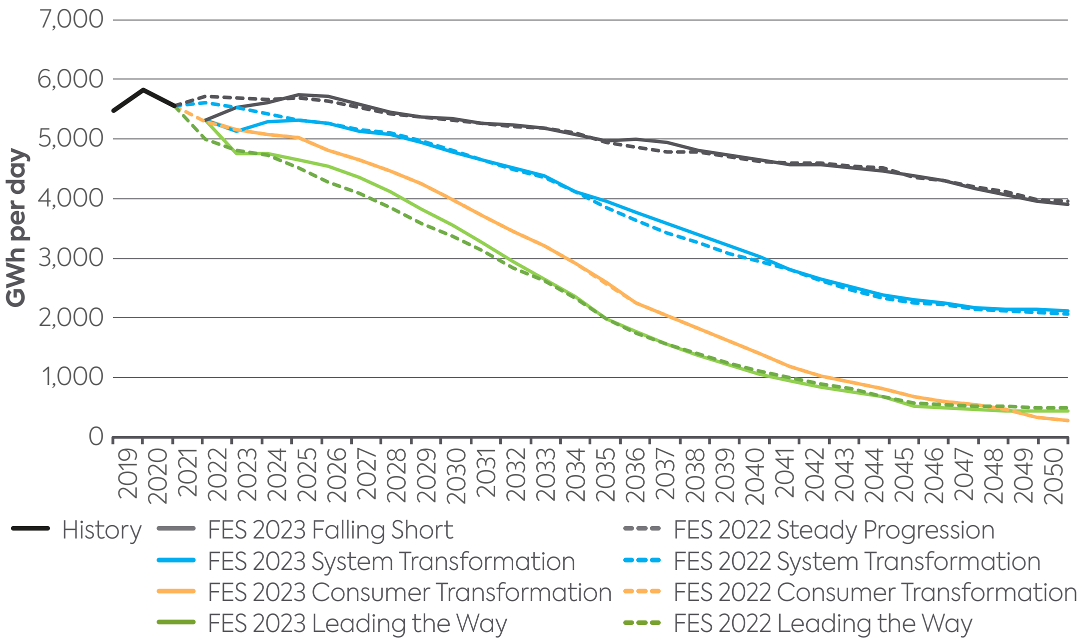
Trends in peak natural gas demand generally mirror annual natural gas demand in each scenario, as many of the factors which influence annual demand also influence peak demand, but the declines are not as rapid.

On cold winter days peak demand will continue to be high while large numbers of homes still rely on gas boilers. As the heat sector decarbonises in the net zero scenarios, with greater use of heat pumps and hydrogen boilers, the peak demand for natural gas will reduce.

Gas is still required as an essential electricity generation source when intermittent power generation is producing less. It is also used for heating in gas boilers, hybrid heating systems (electric heat pumps with gas boilers for peak load) or hydrogen production, depending on the scenario.

We are currently implementing the findings of a review of the Gas Demand Forecasting Methodology. This is to ensure that it remains suitable, especially with the level of change as we move towards a net zero future. We will be consulting on the proposed changes, ahead of implementation, in the production of 2024 FES.

Figure 5
2022 and 2023 FES peak day (1-in-20) gas demand comparison.



1.2 Customer needs

1.2.4 Common Planning Pathway (CPP)

It is becoming increasingly important to review the changes seen in each FES scenario over the next ten years to understand what needs to happen to make each of them credible. With the current lack of incentives in place for consumers to change their behaviour, invest in thermal insultation and convert to net zero heating solutions, we do not expect the demand reductions seen in Consumer Transformation (CT) and Leading the Way (LW) to occur as quickly as predicted. The record gas prices seen recently did drive consumers to turn down their thermostats, but there is no guarantee this will continue as prices reduce.

The Common Planning Pathway (CPP) is a Network Innovation Allowance (NIA) project initiated by National Gas Transmission and delivered by DNV on behalf of the energy networks.

The project aims to define a balanced whole energy system pathway for network infrastructure planning in the UK that:

1. Achieves net zero by 2050; and
2. Can be used by industry for critical network infrastructure planning in defining no regret investment decisions.

The CPP has provided some key insights to support how the Gas Networks should be using the Future Energy Scenarios (FES) for planning purposes.

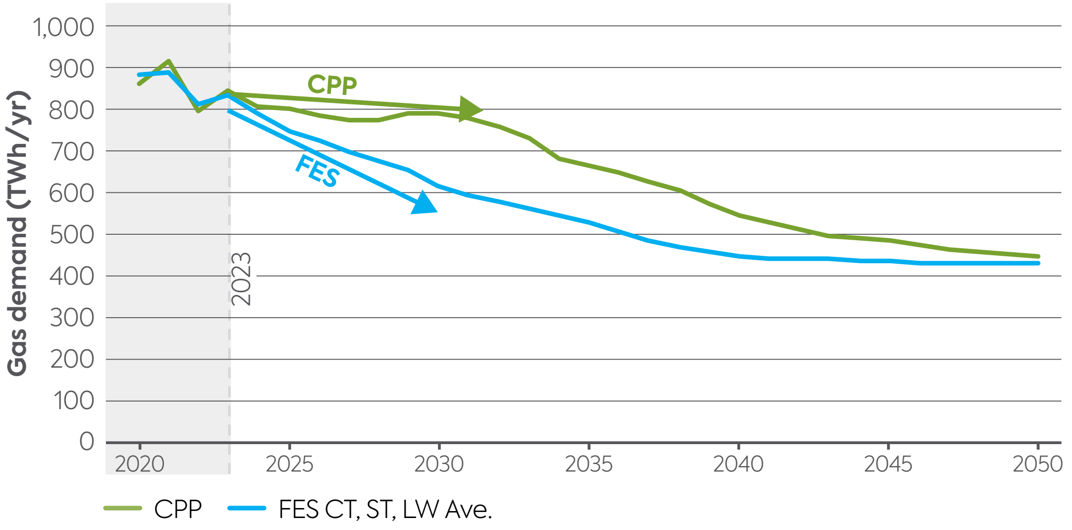
The CPP represents a balanced cost-optimized pathway to net zero by 2050 developed in consultation with industry stakeholders. Based on DNV's annually published Energy Transition Outlook (ETO), CPP has been engineered to meet net zero in the longer term, in the absence of known policy. To do this, various policy levers in the ETO model have been used to represent stronger policies towards decarbonisation. These levers predominantly include Carbon pricing and further incentives to de-carbonise space heating.

Key insights

The CPP methodology is strongly tied to the current state of the energy system. This leads to a significant effect of 'system inertia', which means the pace of change in the short term is relatively slow and uncertainty is low. This highlights the urgency in making policy decisions to accelerate the energy transition. The current energy system is largely made up of carbon emitting assets with long operational lifetimes. For the gas network, these assets include fossil fuel fired power stations and industrial emitters, and domestic gas boilers. Many of these assets are not due to reach 'end of life' in the coming years, so an immediate reduction in emissions from these sources is unrealistic. While we are still installing new gas boilers, and maximising the lifetime of gas fired power stations, the pace of the transition will initially be slow.

When looking at the whole energy system, as the proportion of renewable electricity supply increases, so does the variability of that supply, linked to weather.

Figure 6
Annual Molecule Energy Demand (Methane + Hydrogen)



This places greater emphasis on the need for dispatchable power generation in periods of peak demand or low renewable generation. Currently within the existing power system, dispatchable power is predominantly achieved through methane in power plants. In 2050, under CPP, this will be achieved through hydrogen. This means the gas network will have a critical role in delivering a resilient energy system, through both methane and hydrogen, as expansion of the electricity grid accelerates towards 2050.

1.2 Customer needs

1.2.5 Summary and impact to Future Energy Scenarios

The CPP reinforces that the existing gas networks will be required for quite some time, to enable an energy secure transition to net zero. It has also further reinforced that, for at least the next 10 years, we are unlikely to see a significant change in peak and annual gas demand.

Current policy, system inertia and the ability for the supply chain to deliver electrification is not materialising in line with the current net zero FES scenarios, and is a key driver of uncertainty. Planning the gas networks in line with the findings of CPP provides whole system optionality to address near term risk whilst enabling net zero to be achieved by 2050.

During the last 12 months we continued to use the Steady Progression scenario from FES2021 (SP21) as the high case for the Natural Gas network. Although we still have some concerns with the number of heat pump conversions in the Falling Short scenario in later years, we no longer feel it's possible to continue to base investment on SP21. This is due to the scenario not taking account of the changes in supply and demand post-COVID, the impacts of the Russia/Ukraine war or, the changes in UK net zero policy. Therefore, we will move to the 2023 Falling Short Scenario as the Planning scenario.

1.2 Customer needs

1.2.6 Gas supply

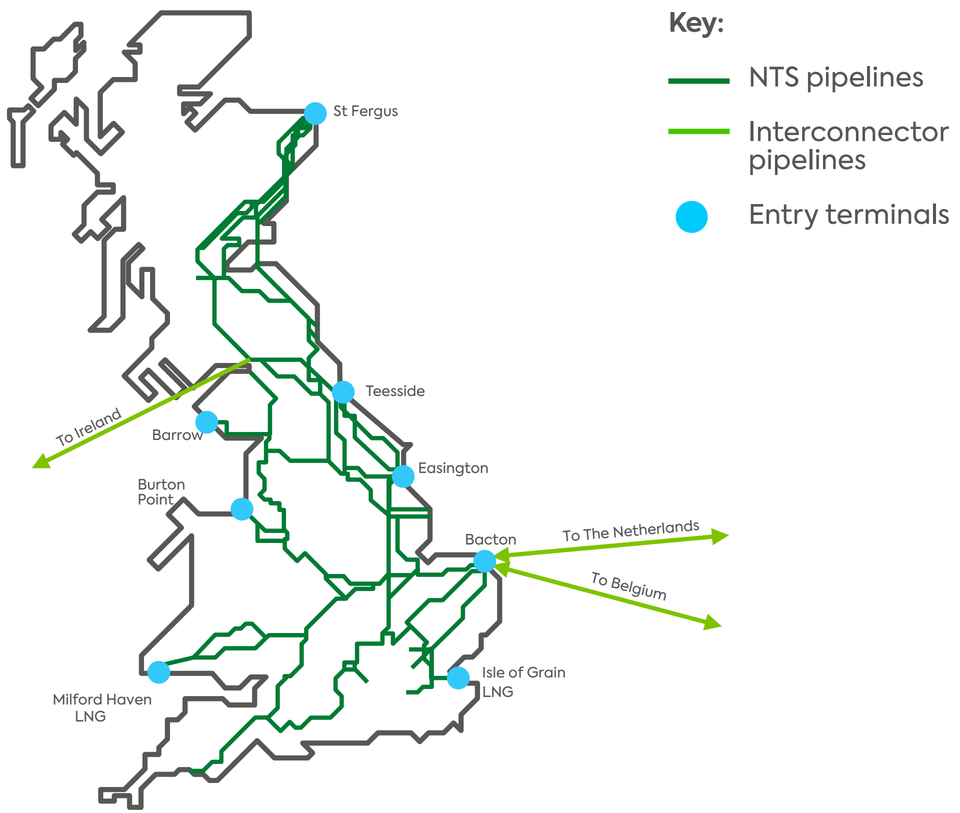
We have diverse sources of supply provided by eight entry terminals (figure 7) onto the NTS. These deliver natural gas from the UK Continental Shelf (UKCS), the Norwegian Continental Shelf (NCS) and Europe, and Liquefied Natural Gas (LNG) from the world market.

We saw a significant increase in gas demand driven by the increase in exports to the European continent. This was driven by the significant drop in Russian exports to Europe and the EU countries being mandated to fill gas storage sites to 80% by the start of winter. This resulted in an increase in UKCS and LNG supplies, and a reduction in supplies from Norway and Europe. The increase in LNG imports is expected to remain high to offset the reduced levels of imports from Europe and to support the increased level of exports to Europe.

The UK is now dependent on imported gas for around two thirds of our gas demand. As our import dependency has increased, the use of our network has changed – with a greater proportion of supply entering the network in the south. We are reviewing our capability to maintain exit pressures in Scotland as supplies at St Fergus continue to decline and demand to Ireland increases.

We are now seeing a greater need for the compression that supports the flexible supply import terminals in the south at Bacton, Isle of Grain and Milford Haven. With some of the compression supporting these terminals impacted by emissions legislation, it is critical we retain the correct level of Network Capability going forward.

Figure 7
NTS gas supply terminals.



1.2 Customer needs

1.2.6 Gas supply (continued)

Figure 8 compares the UK's gas supply composition between 2022 and 2033 for each Future Energy Scenario.

Consumer Transformation (CT)

the lower demands for natural gas necessitates more flexible supply and so this scenario sees the lowest level of supply from UKCS. This also corresponds to the highest proportion of import dependency across the scenarios.

Leading the Way (LW)

has the lowest natural gas demand of the four scenarios in 2033 due to earlier decarbonisation. However, it sees a relatively slower UKCS decline than CT and so our import dependency is less. The drop in demand is driven by fuel switching, thermal insulation of properties and consumers changing their behaviour.

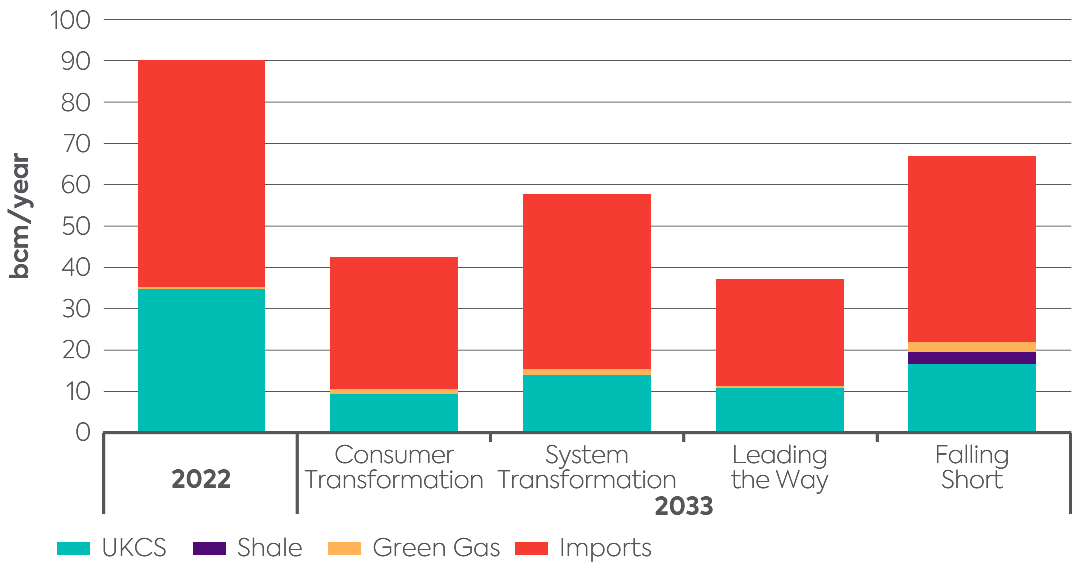
System Transformation (ST)

this scenario sees the highest demand for natural gas in the net zero scenarios. This is due to natural gas being used for low carbon hydrogen production for industry and heat applications. UKCS supplies decline slower than in the CT and LW scenarios but the majority of demand is met via imports.

Falling Short (FS)

has the highest demand for natural gas across the scenarios and the supply mix is closest to today. UKCS supplies at 2033 are also highest in this scenario. There is a higher proportion of green gas supplied, which is valuable for meeting hard-to-decarbonise demand and can be used in negative emissions technologies. Indigenous shale gas enters the supply mix in the early 2030s, which helps to mitigate the risk of import dependency. Removal would see an increase in the import dependence.

Figure 8
Comparison of gas supply by scenario between 2022 and 2033.



1.2 Customer needs

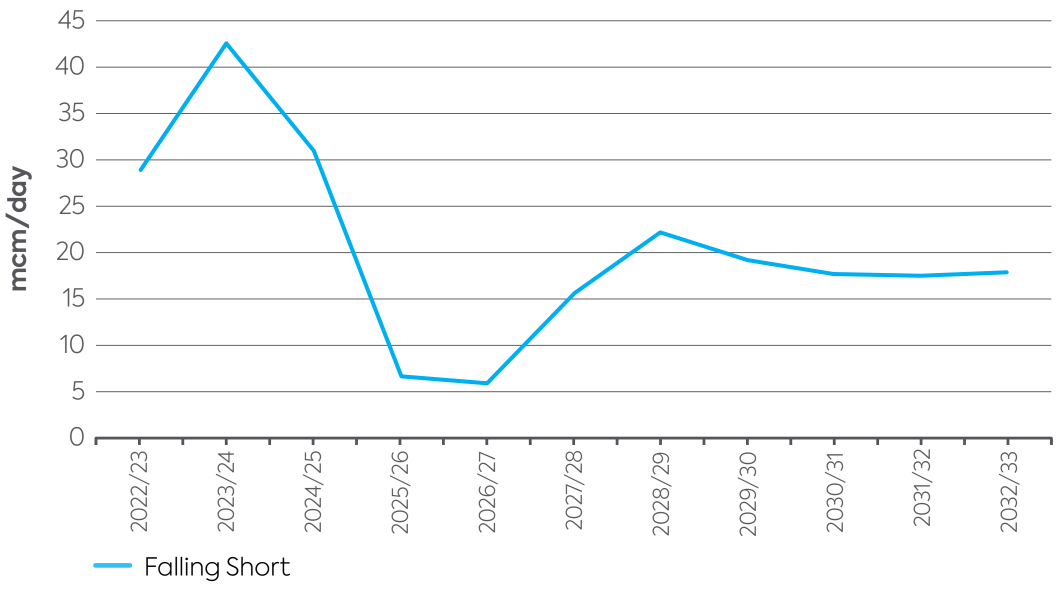
1.2.7 Peak supply

In each scenario, we assess whether the NTS has sufficient supply capability to supply peak demand[1]. To make sure that demand can be met, even if there is a failure in the network, we carry out an assessment assuming that the single largest piece of infrastructure we have is not available. This is known as the N-1 test and is used by the Government in assessing the security of gas supply.

In figure 9 we show the margin of supply over peak demand under N-1 conditions. The figure shows this margin remains positive over the next 10 years. They do, however, tighten as UKCS production falls at a faster rate than demand.

This national assessment is supplemented by more detailed zonal network capability assessments that assess whether the NTS retains sufficient entry capability as supply profiles evolve over time. This is particularly relevant as UKCS continues to decline and our need to import LNG may therefore increase. These assessments are described in more detail in the Network capability chapter of this publication.

Figure 9
Peak supply margin under N-1 conditions.



[1] The quoted numbers differ from those seen in the Winter Outlook publication due to a known network capability constraint being factored into the calculation for that document. The calculation in the GTYS has been completed in line with the methodology set out in Gas (Security of Supply) Regulation EU 2017/1938, incorporated into UK law by the Gas (Security of Supply and Networks Codes) (Amendment) (EU Exit) Regulations 2019.

1.3 Asset management

The NTS is ageing, with many parts of the network more than 50 years old. Carefully managing our asset health is an increasingly important driver of change and trigger for our NDP.

We have developed asset maintenance and asset health programmes to maintain the health of the NTS. Our asset maintenance programme focuses on delivering routine maintenance and monitoring the health of our assets. The asset health programme addresses assets that are either at end of life or have failed, and usually involves refurbishment or replacement, once we have assessed that the asset is still required. These programmes ensure that we can consistently deliver a safe and reliable system to meet the needs of our customers and stakeholders.

Figure 9 describes the measures of risk that comprise our monetised risk-based asset management approach. This framework, now called Network Asset Risk Metrics (NARMs), is being used to consistently assess and prioritise all our asset health investment and ensure that we deliver the work that is most beneficial to our customers and stakeholders.

1.3.1 Developing our asset management approach

Our approach to asset management is based on the ISO 55001 framework. This sustainable, risk-based approach to managing assets is crucial for ongoing realisation of value for money for customers and consumers..

During 2022/23 we continued to drive incremental improvement of the asset management system to enable us to meet RIIO-2 targets and prepare for the next price control period. Initiatives implemented include:

– enhancing the use of the Single Value Framework within our decision support tool (Copperleaf). This enables condition and intervention driver comparison, where all investments can be considered in a common currency of monetised risk.

– aligning our asset taxonomy in our Computerised Maintenance Management System (CMMS), to the ISO 14224 standard, and building intervenable units that form realistic building blocks for our Asset Management Plan (AMP).

Figure 10
Measures of risk.

Category	Service risk measure
Safety	Health and safety of the general public and employees
	Compliance with health and safety legislation
Environment	Environmental incidents
	Compliance with environmental legislation and permits
	Volume of emissions
	Noise pollution
Availability and reliability	Impact of network constraints
	Compensation for failure to supply
Financial	Shrinkage
	Impact on operating costs
Societal and company	Property damage
	Transport disruption
	Reputation

1.4 Legislative change

This section summarises the key legislative changes that can trigger our NDP, as these changes will impact how we plan and operate the NTS over the next ten years.

1.4.1 Emissions legislation

The Industrial Emissions Directive (IED) is the mandatory minimum emission standard for large combustion plant (> 50 MWth) that all European countries must comply with by 2023, and applies to our larger gas-powered compressors.

The Medium Combustion Plant (MCP) Directive has a compliance date of 1 January 2030 and applies to the remainder of our gas-powered compressors (> 1 MWth and < 50 MWth).

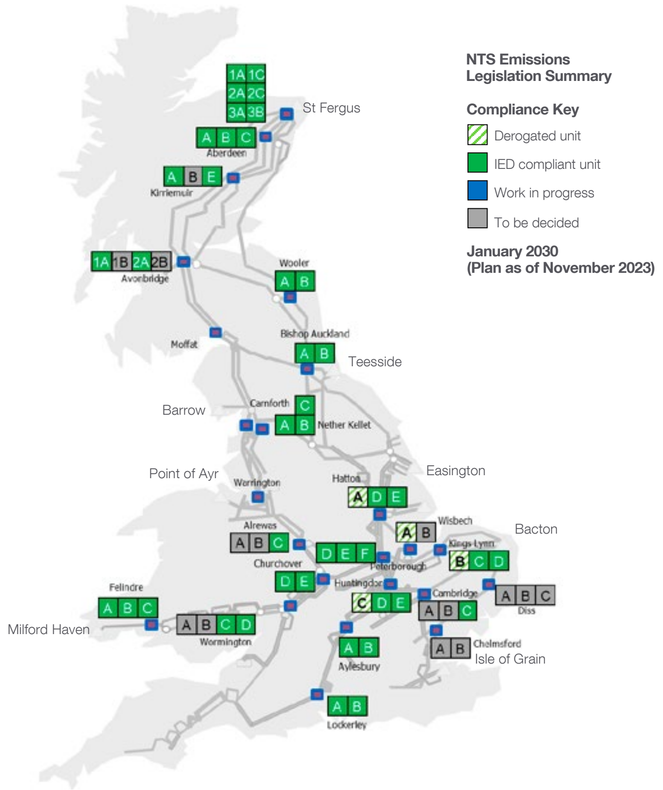
All of our compressors are compliant with current legislation, but many of our compressors require intervention to ensure compliance by the appropriate date. These interventions include decommissioning, replacement with new compliant units, having emission abatement technology fitted, or being put on Emergency Use Derogation (i.e. having strict run hour limits).

Work is in progress at several sites to deliver compliance to the 2023 IED deadline. Details on decisions and progress we have made at individual sites are available in the Options and developments section of this publication.

The map, figure 11 shows the sites with funding agreed and development in progress – units coloured blue. Units where funding is yet to be agreed, or further analysis is required, are shown in grey. Units where we are confident we no longer need the capability, and the decision has been made to decommission the unit or site, are shown in black. Green denotes units that are compliant with future emissions legislation and do not require intervention.

You can find more information about our activities around emissions legislation in our Compressor Emissions Asset Management Plan.

Figure 11
NGT compressor fleet status now, and potential 2030 status.



1.4 Legislative change

1.4.2 Gas quality

In January 2022, the Health and Safety Executive (HSE) published a consultation and impact assessment on proposals to change the Gas Safety (Management) Regulations 1996. Following a review, in April 2023, the Gas Safety (Management) (Amendment) Regulations 2023 entered into force. For full details see appendix 4.

1.4.3 Cyber protection

The Security of Network and Information Systems Regulations (NIS Regulations) came into force in the UK on 10 May 2018. The NIS Regulations provide legal measures to boost the level of security (both cyber & physical) of network and information systems for the provision of essential services such as energy.

As an operator of Critical National Infrastructure (CNI), we are investing to secure critical network and information systems to keep our business, employees and customers protected.

Our network and industrial control systems are subject to a multitude of security threats, which continue to change and vary in sophistication and persistence. These threats include criminality, espionage, activists and extremists, vulnerabilities within systems and vulnerability from insider action. We work closely with Ofgem, DESNZ and the National Cyber Security Centre (NCSC) as part of our RIIO-2 business plan for cyber resilience.

In RIIO-2 our investments also cover the latest phase of the Physical Security Upgrade Programme (PSUP) – a DESNZ led national initiative to enhance physical site security which commenced in RIIO-1. This includes a rolling asset replacement programme for IT hardware and technical assets

1.5 Net zero

Climate change is the defining challenge of this generation – the decisions we take now will influence the future of our planet. To meet our vision of being at the heart of a clean, fair and affordable energy future, we are constantly monitoring and evolving our organisational capability. We have already made good progress on reducing our emissions – by 68% since 1990. This is well ahead of our original target of 45% by 2020.

Since 2020, the policy landscape with respect to net zero has evolved significantly. A few of the policies published include the Ten Point Plan for a Green Industrial Revolution, the Energy White Paper and the Climate Change Committee's 6th Carbon Budget.

Last year we saw the UK Government pass into law a new target to deliver a 78% reduction in CO_2 emissions by 2035, in line with the recommendation from the Climate Change Committee (CCC). We also need to ensure that the Paris Agreement, a legally binding international treaty on climate change, is achieved. Its goal is to limit global warming to well below 2°C, preferably to 1.5°C, compared with pre-industrial levels.

With the need for cleaner energy, new changes to legislation and the target of net zero by 2050, net zero is becoming a more important driver of change for us. We will lead the way in the decarbonisation of gas, investing in a range of solutions such as renewable natural gas, using blended hydrogen in our network and carbon offsetting. Continuing projects such as ProjectUnion and FutureGrid are key to achieving this target.

1.5.1 Hydrogen

Today, natural gas plays a key role in the energy landscape: delivering three times as much energy as electricity; keeping 85% of the UK's 28 million homes warm; generating electricity and fuelling many industrial and manufacturing processes.

Hydrogen has been identified as a potential low-carbon replacement for natural gas. Converting our network to carry hydrogen would be a lower-cost, less disruptive option for customers and consumers than replacing our entire network. The UK's Hydrogen Strategy estimates that 250–460TWh of hydrogen could be needed in 2050 to meet net zero, which would make up 20–35% of final energy demand.

The hydrogen policy landscape continues to evolve, some targets include:

- 2GW of hydrogen production capacity by 2025 and 10GW of hydrogen production capacity by 2030 with over 50% of this coming from electrolytic hydrogen
- the first 100% hydrogen village by 2025 and the first hydrogen town by 2030
- hydrogen heating decision by 2026
- new business models for hydrogen transport and storage infrastructure designed by 2025.

Following extensive consultation with stakeholders we have also published our Hydrogen Roadmap to 2050, showing a potential timeline for the journey to net zero.

10GW
of hydrogen production capacity by 2030

100%
hydrogen village by 2025

1.5 Net zero

1.5.2 Building the evidence base for hydrogen

Over the RIIO-2 period (2021–2026), we are continuing to build the technical and safety evidence to enable the transition to hydrogen. This will allow us to be ready to start the conversion to hydrogen by 2026 as committed to in our RIIO-2 business plan.

We are doing this through a number of mechanisms including our innovation programme, FutureGrid and through industry-wide collaboration. All these activities will enable us to start the transition from natural gas to hydrogen which is being delivered via the flagship programme, ProjectUnion.

In July 2020, National Gas Transmission submitted the FutureGrid project as part of the Network Innovation Competition (NIC) process. The FutureGrid project has built a hydrogen test facility from a representative range of decommissioned assets. Flows of hydrogen and natural gas blends (up to 100% hydrogen) will be tested at transmission pressures to better understand how hydrogen interacts with the assets.

You can find more information on FutureGrid here.

1.5.3 Collaboration across the industry

Gas Goes Green

The Energy Networks Association's (ENA) Gas Goes Green (GGG) programme launched successfully in April 2020, bringing together all five of Britain's gas networks to deliver the world's first zero-carbon gas grid. The Gas Goes Green Pathway to Net Zero sets out the actions required to achieve this. Since the launch of the programme, several joint reports have been published including:

- Britain's Hydrogen Network Plan
- Britain's Hydrogen Blending Delivery Plan.

European Hydrogen Backbone

The European Hydrogen Backbone (EHB) initiative consists of 31 gas infrastructure companies across 28 countries working collaboratively to develop a vision of how dedicated hydrogen infrastructure would develop. In April 2022, an updated vision of the EHB was published, showing a truly pan-European hydrogen network.

1.5 Net zero

1.5.4 Innovation

In 2022/23, we increased our focus on hydrogen-related projects to help us reach our target of net zero by 2050. As part of this, we undertook 17 projects with £2.17m in funding from the Network Innovation Allowance (NIA).

In RIIO-1, we delivered several projects looking into the capability of the National Transmission System (NTS) to transport hydrogen, and we've continued building on this work, undertaking a wide range of projects that explore the opportunities surrounding hydrogen as an alternative to natural gas.

This includes looking at the possibility of transporting blends of natural gas and hydrogen, identifying the available technology options for 'deblending' hydrogen and exploring whether our existing compressor units can successfully operate with hydrogen. In addition to this, we also looked at ways in which our asset data will need to improve, and the digital technologies available to support us with this improvement.

Last year, the process for the new Strategic Innovation Fund (SIF) began. Alongside our NIA projects, we submitted applications for 11 SIF Discovery phase projects and were delighted to be awarded funding for 10 of them. These projects lasted for two months, concluding in April 2022, and focused on better understanding some of the challenges associated with converting our network to carry hydrogen.

Following their conclusion, we were awarded funding of £1.7m to carry out four projects as part of the next phase of the SIF process – the Alpha phase. You can find out more about these projects in our Options and developments section.

2 Network capability and resilience

2.1 Introduction

This chapter explores the second stage of our Network Development Process (figure 12). Here, we give details of how we analyse and assess the required capability of the NTS to address the drivers of change in each zone.

The network capability process enables us to demonstrate the physical capability of the NTS and how that capability compares to the needs of our customers, now and into the future.

This assessment is carried out against a range of future supply and demand scenarios using the Future Energy Scenarios (FES).

Figure 12
Our Network capability & resilience process.

2.2 Network Capability Assessment & Network Resilience

Since 2021, we have published an Annual Network Capability Assessment Report (ANCAR) in June of each year. The document includes information at entry and exit zone level, on both the level of physical Network Capability and also the level of Network Capability that can be delivered using commercial tools.

Our most recent ANCAR was published in June 2023.

Our Network Capability process enables us to calculate and demonstrate the physical capability of the National Transmission System (NTS) and how that capability compares to the needs of our customers now and into the future. This assessment is carried out against a range of future supply and demand patterns. The output of this assessment helps inform and evaluate potential changes to physical assets through the Network Development Process to ensure continued safe and economic operation of the NTS in meeting our customers' needs.

Investment in improving network resilience is crucial to ensure we can maintain safe and efficient operation of the network, meet our customer requirements and associated obligations. We therefore included a heavier focus on network resilience in ANCAR 2023.

Going forward, network resilience will continue to be a high priority area for us and during the RIIO-3 business planning process we will be considering what improvements we should undertake for sites with lower resilience than we'd like. See more in section 2.4.

As part of our commitment to continual engagement, we have provided updated flame charts in this document.

These updates are based upon the Network Capability analysis published in ANCAR 2023, with the most recent supply and demand flow scenarios applied. The flame charts for this analysis can be found in appendix 2.

The specific projects being undertaken in each zone are summarised on the next page, and further information about each individual project can be found in the Options and developments section.

2.3 Summary of changes by zone

Scotland and the North (zone 1)

The trend of supplies into the St Fergus entry terminal continues to reduce over the coming years, which could result in low pressures or exit constraints. We will continue to assess this as part of both the ANCAR process and the projects noted below:

St Fergus

North East (zone 3)

There are no significant changes driven by our network capability assessment however there is a legislative change project at a compressor site:

Hatton

South Wales (zone 4)

Due to forecast LNG supply increases there continues to be a growing number of occurrences where supply may be above capability. This zone has the strongest indication that there may be a need for increased capability. A number of projects are in progress for this zone:

Western Gas Network

Wormington

East Midlands (zone 6) and South East (zone 7)

Export flows via the Bacton interconnector continue to cause some uncertainty about the level of exit flows we may see going forward. This will be a key area of focus for us and a number of projects are ongoing:

Bacton Campaign

King's Lynn

South West (zone 5)

There are no significant changes in this zone, however we are delivering legislative change projects at two of our compressor sites in the South West:

Peterborough & Huntingdon

The UK and other countries have increased their attention on energy resilience. This has been driven by recent global events, such as the curtailment of Russian gas flows into continental Europe, which are having a profound and long-lasting impact on how energy security is perceived and delivered.

The impact of these global events has resulted in significant increases in wholesale energy prices and has a part to play in the ongoing cost of living crisis. Events that have previously been considered credible but low probability have materialised and brought into focus the need to be able to manage these events across the UK's energy infrastructure.

A resilient network is crucial to managing the impacts of such global events to ensure the network can efficiently transport gas supplies to meet the required demand. In recent years the way in which the network is used by customers has changed significantly and the volatility seen is increasing. As a result of this the UK Government have outlined a number of key commitments within the Energy Security Plan, their Powering up Britain Publication, to enhance the UK's energy security.

Actions

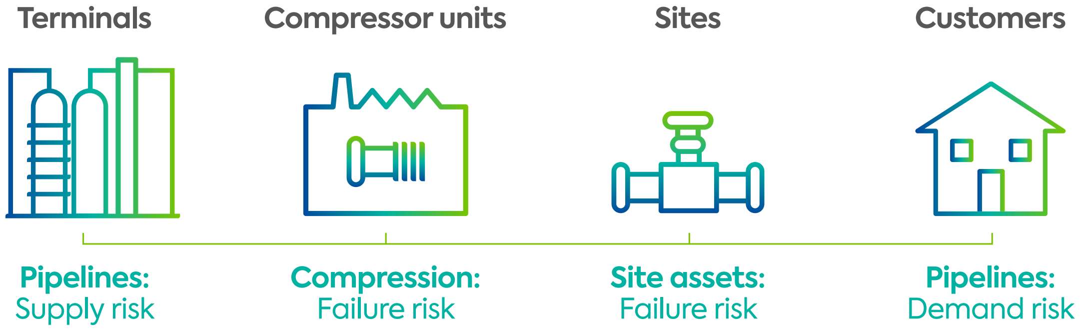
In response to the UK Governments Energy Security Plan, we have mobilised a programme of work to address our immediate concerns on resilience to focus on capability risk (the ability for the network to accept and transmit gas to demand primarily requiring network compression), supply and demand risk (areas of the network where only a single transmission asset exists), and overall failure risk (sites). There are other elements of resilience that are being considered as part of Asset Management Strategy including environmental conditions i.e., the ability to manage the network under extreme temperature conditions, flood defence etc.

The initial focus of the Network Resilience Programme has been to review the Transmission Planning Code (TPC) and propose three areas of change that we believe will aid the delivery of a standardised approach to planning and developing the NTS in response to both capability and resilience requirements.

Peak Demand – Clarify that only assets can ensure that the system can meet the pipeline system security standard and 1 in 20 demand levels, and the associated range of supply scenarios to meet that demand.

Supply Scenarios – Clarify that the network should be capable of accepting the maximum physical flow from each terminal, interconnector, and storage site to demonstrate that peak demand is achievable should any one entry point flow at its maximum.

Figure 13
National Transmission Network Resilience Components



Standby Compression – Clarify that any compressor on the NTS network which is required to meet the peak 1 in 20 obligations requires a fully available and unrestricted standby unit and this standby unit should therefore cover all failure scenarios.

The changes to the TPC went out to industry for consultation at the end of September and closed on the 17 October. We have submitted the proposed changes to Ofgem and we are awaiting their approval.

3 Options and development

3.1 Introduction

This chapter summarises the options and developments stages of our Network Development Process (NDP), where options are identified and the preferred option is progressed to address the drivers of change (figure 14). The chapter focuses on specific project details and their current development status.

Stage 3 of our NDP comprises the identification of options using a mix of rules (industry frameworks), tools (commercial arrangements and operational strategies) and assets (physical solutions to ensure we retain the required level of network capability). Each option can have a mixture of solutions, with elements of asset solutions alongside both rules and tools.

Stage 4 of our NDP is only reached if the optimal solution to a driver of change cannot be found within our existing network capability. The aim of this stage is to further develop the preferred options based on the direction of travel decided in stage 3. It may be necessary to progress multiple options at the same time to ensure the optimal final solution is progressed to completion.

Figure 14
Our Network Development Process.

3.2 Zone 1: Scotland and the North

Project: St Fergus terminal
Category: Asset Management, Legislative change

Background
St Fergus terminal is an entry point into the UK in the North of Scotland. The terminal was built in 1975 in a coastal environment which accelerates corrosion degradation. Across the site, investment continues to be made across a number of workstreams to address existing issues that may pose a potential safety risk, while in parallel retaining appropriate levels of compression availability and capability and meeting environmental targets.

Status
Our RIIO-2 plan for St Fergus seeks to optimise investment aligned with managing safety and reliability risks on aging assets with the efficient delivery of our future compression strategy for the terminal.
We submitted an Uncertainty Mechanism in 2023 seeking funding for three new units and trial of a retrofit emissions compliance solution with associated Asset Health investments.

Next steps
Install three new units and one trial retrofit emissions compliance solution by 2030 (Ofgem published their decision supporting our proposal).

More information about our public consultation for St Fergus can be found on our website.

3.3 Zone 3: North East

Project: Hatton compressor station
Category: Legislative change

Background

Hatton compressor station provides network entry capability in the North East and supports network exit capability in the South East and South West. The station consists of one electric unit and three gas-powered units. These latter units are within scope of the IED and will need to be decommissioned or operate with restricted running hours by the end of 2023 in order to remain compliant.

Status

Funding was awarded through RIIO-2 final determination for a single large gas-powered compressor and decommissioning two older, non-compliant units.

Next steps

The investment will be completed during the RIIO-2 period.

The new compressor is planned for operational acceptance in Feb 2024, the unit has been delivered to site and work has started.

More information about our Hatton Gas Compressor Upgrade programme can be found on our website.

3.4 Zone 4: South Wales

Project: Western Gas Network project
Category: Customer need

Background

In 2018 a Planning and Advanced Reservation of Capacity Agreement (PARCA) application was received for the Milford Haven Aggregated System Entry Point to increase the current entry capacity baseline from 950 GWh/d to 1,113 GWh/d.

Status

Ofgem have approved the needs case and consulted on the project determination.

A thorough and detailed analysis of our network revealed the option with the least amount of new infrastructure, the least impact on people and the environment, at the least cost, representing the best value for UK consumers. The work, collectively known as the Western Gas Network project, involves 11km of new pipeline, pressure uprating of the existing pipeline between Felindre (Swansea) and Three Cocks (Powys) and supporting works.

Next steps

We currently await capacity allocation and Ofgem publication of a Project Direction, at which point we can implement detailed design and build phases of the project.

More information about our Western Gas Network project can be found on our website.

3.4 Zone 4: South Wales

Project: Wormington compressor station
Category: Legislative change

Background

Wormington compressor station supports network entry and exit capability in South Wales. The station consists of one electric unit and two gas-powered units. The latter two units are within scope of the MCPD and therefore will need to be decommissioned or operate with restricted running hours by January 2030 in order to remain compliant.

Status

In August 2022, through the Wormington Uncertainty Mechanism, we submitted proposals to achieve MCPD compliance. In March 2023, Ofgem subsequently published confirmation of the Final Preferred Option, comprising the installation of a new gas turbine compressor unit (approximate size 15MW) commissioned before 1 January 2030. The new unit will be installed within the existing boundary of Wormington compressor station. In addition, one of the existing Avon units is to be retained, under the 500-hour Emergency Use Derogation allowed for in the Directive, with significant asset health investment to improve unit availability. The other Avon unit will be decommissioned. Ofgem have also confirmed that if an emissions reducing option becomes available, that will permit unrestricted operation of all units at Wormington compressor station, then this should be progressed subject to agreement of additional funding by Ofgem.

Next steps

Detailed design of the preferred option. We are also investigating the feasibility of retrofitting the implementation of Dry Low Emissions (DLE) technology for the units currently non-compliant with MCPD, and we will continue to assess the future requirements at the site,

3.5 Zone 5: South West

Project: Peterborough and Huntingdon compressor stations
Category: Legislative change

Background

Peterborough and Huntingdon compressor stations support network exit capability in the South East and South West. They have been considered together due to their operational interdependence.

Each station consists of three gas-powered units. These units are within scope of the IED and MCPD, and will need to be decommissioned or operate with restricted running hours by December 2030 in order to remain compliant.

Status

We are continuing with works at Huntingdon and Peterborough compressor sites to deliver two new IED compliant gas turbines on each site by the end of 2023. The new units, each 15.3MW in size, are manufactured by Solar Turbines.

We submitted a UM outlining the need for one additional new gas-driven compressor unit in Peterborough and installation of DLE Emission Abatement technology on the Avon unit at Huntingdon to Ofgem in RIIO-2. Ofgem have published decision supporting our proposals at both sites.

Next steps

Detailed design of the preferred option.

3.6 Zone 6: East Midlands

Project: King's Lynn compressor station
Category: Legislative change

Background
King's Lynn compressor station supports network entry and exit capability in the South East and East Midlands. The station consists of four gas-powered units. Two of these units are within scope of the MCPD and therefore will need to be decommissioned or operate with restricted running hours by January 2030 in order to remain compliant.

Status
In our RIIO-2 Business Plan we proposed that two compliant gas-powered units should be installed at King's Lynn in order to maintain existing capability and resilience at this station. We submitted a UM requesting a new unit. Ofgem published their decision not supporting a new unit.

Next steps
We will continue to assess the level of need at this site.

3.7 Zone 7: South East

Project: Bacton terminal
Category: Asset Management

Background

The Bacton terminal is a key strategic gas terminal into the UK and will continue to operate until at least 2050 under our current FES scenarios. The site commenced operation in 1968 in a coastal environment which accelerates degradation, and has operated continuously since, with no site-wide outages. Examination of the risks and consideration of the needs case work at Bacton has identified issues that should be prioritised in the short term and we are considering options to retain safe operation of the site for the long term, and in consideration of net zero.

Status

To support our long term options assessment process we have completed additional Reliability, Availability and Maintainability (RAM) and Reliability studies and have installed electrical resistance probes at the site to gather further information on the condition of the below ground assets, including the performance of the cathodic protection system. This information has fed into the optioneering that we have undertaken as part of the Future Operating Strategy Uncertainty Mechanism workstream. Our submission to Ofgem will present a preferred option to ensure Bacton terminal is fit for purpose to 2050 and beyond.

Next steps

Whilst this option selection phase is ongoing, we are undertaking asset health works to maintain the safety and reliability of the current assets. Some of these investments have baseline funding whilst other works will be subject to an Uncertainty Mechanism in early 2024.

3.8 National

Project: Redundant assets
Category: Asset management

Background

As the requirements on the NTS change, there are assets on the network that are no longer required by National Gas or our customers to operate the network – these are defined as redundant assets.

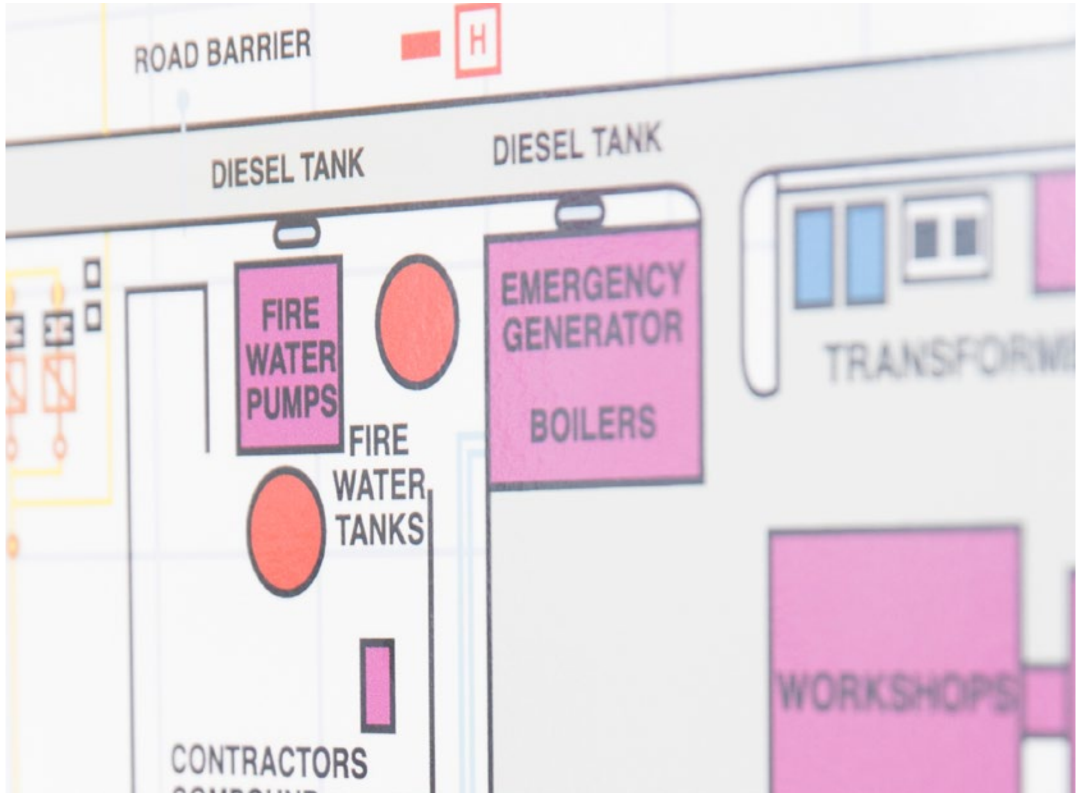
Assets that remain on the network for longer than required represent an ongoing maintenance committment and operational cost, as well as having the potential to cause detrimental impacts to the environment.

Status

A range of scopes to decommission redundant assets and sites were identified and funding awarded through the RIIO-2 final determination. In the first two years of RIIO-2 we have completed 10 outputs against the Redundant Asset Price Control Deliverable. In addition to this, a further 16 outputs have been developed through 2022/23 with delivery planned in 2023/24.

Next steps

Projects continue to be delivered according to our RIIO-2 plan. We continue to assess the needs for all of our assets and will continue to remove assets which are no longer required to meet consumer demands.



3.8 National

Project: Physical Security Upgrade Programme
Category: Legislative change

Background

Our network is subject to a multitude of security threats, which are ever-changing and increasing in sophistication and persistence. These threats include criminality, espionage, activists and extremists, vulnerabilities within systems and vulnerability from insider action.

Additionally, there is a rapidly growing threat to industrial control systems due to cyber-attacks from a range of hostile forces.

The Physical Security Upgrade Programme (PSUP) is a DESNZ led national programme to enhance physical site security, which commenced in RIIO-1.

Status

In RIIO-2 our investments cover the latest phase of sites agreed with the government.

Next steps

Given the relatively short asset lives of the IT hardware and technical assets within these solutions, we have also commenced a rolling asset replacement programme at the sites where solutions were installed in the early phases of the PSUP.

3.9 Cyber protection

Project: Cyber protection
Category: Legislative change

Background

The Security of Network and Information Systems Regulations (NIS Regulations) came into force in the UK on 10 May 2018. The NIS Regulations provide legal measures to boost the level of security (both cyber & physical) of network and information systems for the provision of essential services such as energy.

Status

As an operator of Critical National Infrastructure (CNI), we are investing in our cyber resilience as part of our RIIO-2 business plan and in accordance with the the UK's Cyber Assessment Framework (CAF).
.

Next steps

We continue to deliver the plan that has been agreed with Ofgem and DESNZ.

3.10 Methane emissions

Project: Methane emissions
Category: Legislative change

Background

At COP26 the UK government, along with 121 other governments, committed to the Global Methane Pledge with the aim of reducing global methane emissions by 30% from a 2020 baseline.

Rapidly reducing methane emissions will help to remain on track with the goal of limiting global warming to 1.5°C and prevent the worst consequences of climate change.

Status

We developed three uncertainty mechanism submissions collaboratively with Ofgem under the Net Zero Pre-Construction and Small Projects re-opener ('the NZASP re-opener'). These were submitted at the end of 2022 and sought investment in equipment and technology to reduce methane emissions from operating the NTS and improve detection and quantification of fugitive gas escapes. Ofgem are currently consulting on their draft determination following a review of these submissions.

Next steps

Ofgem to issue final determination and seek National Gas Transmission acceptance of awarded allowances. Projects linked to these investments will then move into delivery.

More information on Ofgem's consultation can be found here.

3.11 Net zero

Project: HyNTS compression
Category: Net zero by 2050

Background

To transport and store hydrogen across the UK, compression is required to provide flow and build linepack at times of increased demand and in certain locations on the network. To meet our net zero targets by 2050, we're exploring the feasibility of converting the NTS to carry hydrogen. Through the Strategic Innovation Fund (SIF) process, we're working to build our understanding of how our current compression equipment can be repurposed for hydrogen and hydrogen blends.

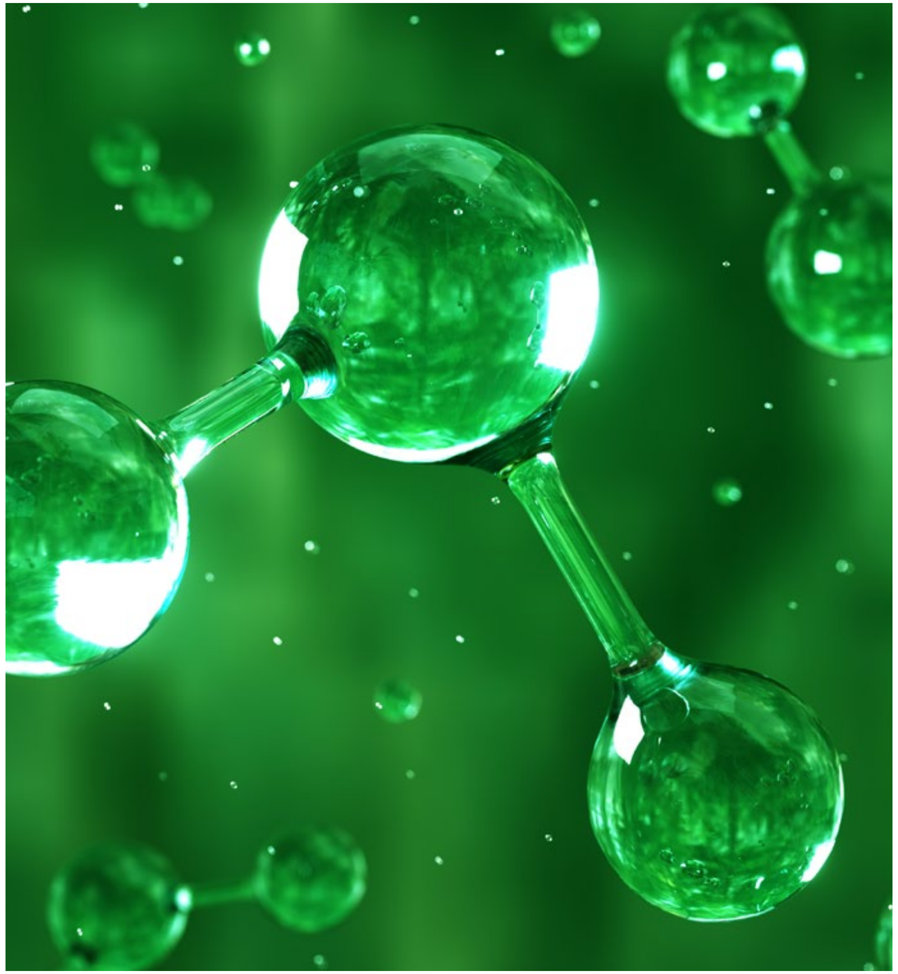
Status

We undertook an initial Discovery phase study to determine the full range of technical requirements for potential compression drive systems and compressor technologies. This was followed by an Alpha phase project to further develop our understanding of the feasibility of repurposing compressor assets, as well as modelling future compression requirements. The projects showed that our gas turbines could be modified to be fuelled with up to 100% hydrogen and our compressors could operate with up to 50% hydrogen. Above 50% hydrogen, a compressor upgrade would be required. The cost of an entirely new compression system is approximately £60m per unit, so repurposing our existing assets would result in considerable cost savings for consumers.

Next steps

We've now received funding for a larger Beta phase project. A gas turbine representative of the current fleet will be fuelled by different blends of hydrogen up to 25%, then following modifications, 100% hydrogen.

This will provide technical and safety evidence for the repurposing of our current gas turbine fleet. Following this, the full compression system including the power turbine, gas compressor and the cab and ancillary equipment will undergo offline testing at the FutureGrid hydrogen test facility, to demonstrate that the assets can be repurposed for hydrogen blends and 100% hydrogen. A compression test loop will be constructed out of decommissioned NTS assets to test the compressor systems in a range of hydrogen scenarios. The HyNTS Compression Beta project will provide a technical demonstration and create a strategy for the transition of the UK NTS compression system to hydrogen.



3.11 Net zero

Project: HyNTS deblending
Category: Net zero by 2050

Background

Through the Strategic Innovation Fund (SIF) process, we have been looking at the concept of gas separation or 'deblending' of the gases within the high-pressure NTS to enable delivery for transport applications.

Without this technology, refuelling of transportation assets will be limited to the use of locally produced hydrogen or tanker deliveries, until the gas networks can transport near pure hydrogen. This will limit the availability of large-scale hydrogen infrastructure and affect the speed of transition for the transport industry, particularly large vectors such as HGVs, trains, buses and marine.

Status

We undertook an initial Discovery phase study that explored the different deblending technology options, specifically those that could enable the connection of transport refuelling facilities onto the gas network, with the aim to provide more resilient hydrogen fuelling infrastructure.

We found that hydrogen blending and deblending is a cost-effective method for hydrogen distribution in the transport sector, and we developed an initial concept for the technology.

This was followed by an Alpha phase project to select the optimum technology for separating gases from the NTS and develop detailed designs for a deblending and refuelling system tailored to our network and the needs of hydrogen transport users. The project also looked at the potential of demonstrating the solution at the FutureGrid hydrogen test facility.

Next steps

We've been awarded funding for a larger Beta phase project to deliver the demonstration of gas separation technology.

This will involve showcasing the full process, starting with taking blended transmission gas through separation, purification, and compression processes, and culminating in refuelling hydrogen vehicles of a variety of sizes. We need to show that the technology can operate with fluctuations in gas temperature, flow, pressure, and composition and variations in these parameters will form our test plan.

3.11 Net zero

Project: Multiple gas detection
Category: Net zero by 2050

Background

As part of our ongoing network maintenance activities, we use specialist gas sensor technology to monitor the concentration of flammable gases present within a work area. These safety sensors will issue an alert when the levels are close to being potentially dangerous.

Gas safety sensors currently in use across our network are only capable of detecting the quantity of natural gas and we do not currently have fugitive emission continuous monitoring equipment installed. As we transition our network to a greener alternative such as hydrogen, we need sensors that can detect varying blends of natural gas and hydrogen.

Status

We're running a project to test NevadaNano's Molecular Property Spectrometer (MPS) multi-gas sensor, which should be able to simultaneously analyse mixes of hydrogen and natural gas with a single calibration, enabling us to locate and quantify fugitive emissions.

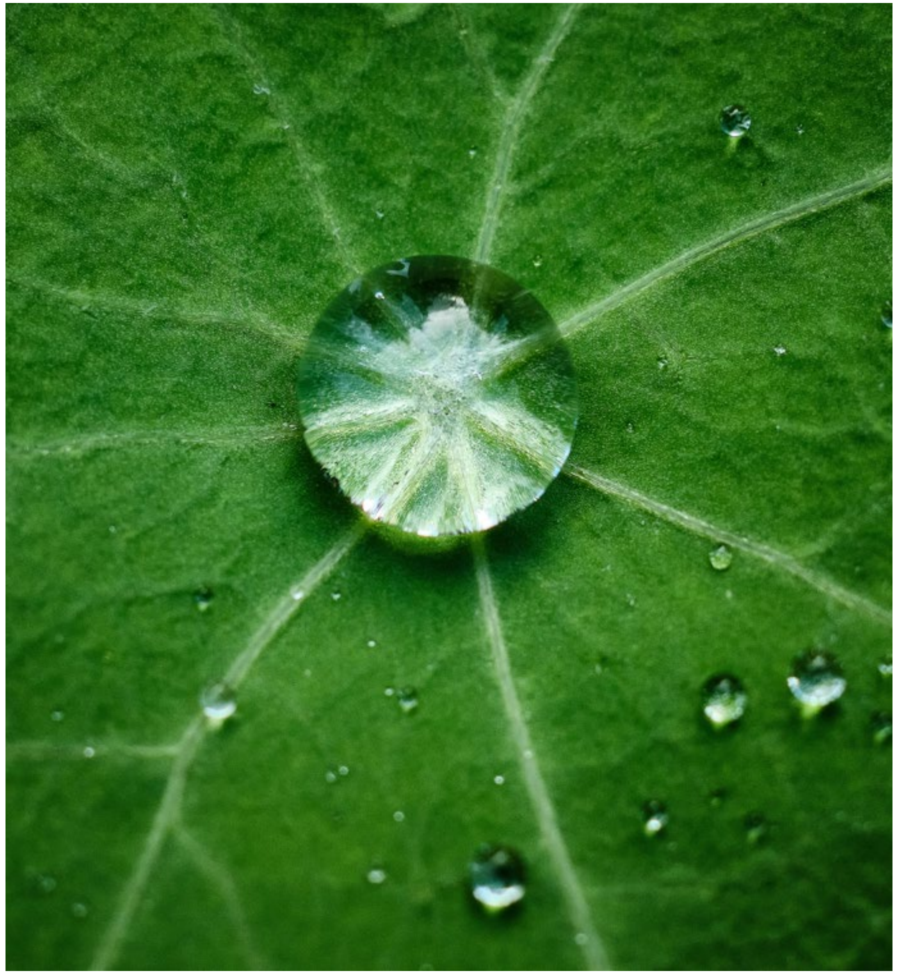
Next steps

We'll undertake a thorough review of the sensor technology and how it relates to other gas detection systems on the market, including a lab-based demonstration with various gas types and blends of hydrogen and natural gas.

We'll use the FutureGrid test facility to conduct a physical demonstration with hydrogen blends. Once we've determined the best locations for the sensors, leak monitoring will be carried out on site for 12 months.

Finally, we'll be demonstrating the technology with natural gas at an existing operational site, which will include undertaking a site survey to determine suitable locations for each sensor to be installed, to effectively monitor fugitive emissions on site for three months.

3.11 Net zero



Project: Collaborative visual data twin phase one
Category: Net zero by 2050

Background

The introduction of hydrogen into our network adds complexity which could be managed and supported by digital tools. In January 2022, we started a project looking at developing a robust, low-cost solution for combining virtual twins and data twins into a single, robust digital twin.

A digital twin is a virtual representation of a system that covers its whole lifecycle. It's updated using real-time data and uses simulation and machine learning to help with decision-making.

Status

Using the FutureGrid hydrogen test facility as a case study, we completed a series of site surveys, using photography, drone footage and laser scanning technology. The data gathered was used to create different visual 3D representations of the site, including engineering and rendered models.

Alongside this, we looked at the requirements for a data storage and management system that can support both historic and live site data. This system has been used with live data from the FutureGrid project, and will remain available to the project team throughout the project.

We also undertook stakeholder engagement activities to ensure this proposed system suitably aligns with the current business-as-usual approach.

Next steps

The outcomes of the project are being used in a second phase, to build and demonstrate the digital twin proposed solution developed in phase one. This model will be used to visualise and better understand any asset changes that occur because of exposure to hydrogen.

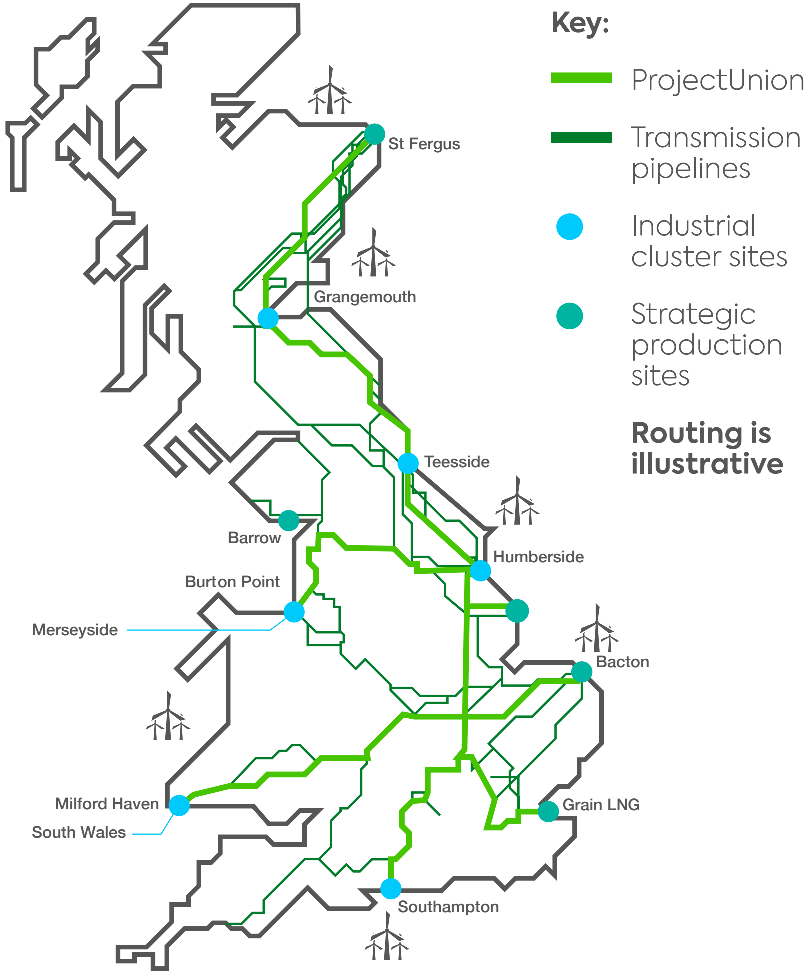
Both phases of the project will ultimately help us make more robust asset management decisions and will allow us to make predictions on future scenarios and conduct risk analysis using improved analytics and structured, linked datasets.

3.12 ProjectUnion

ProjectUnion will connect and empower a UK hydrogen economy, repurposing existing transmission pipelines to create a **hydrogen 'backbone' for the UK by the early 2030s**. ProjectUnion is a critical step towards net zero.

It spans across the UK connecting all major industrial clusters, hydrogen production centres and linking hydrogen supply and demand. A circa 2,000km hydrogen backbone would be created, representing around 25% of the UK's current natural gas transmission pipelines.

In April 2023, National Gas was awarded £5.626m funding from Ofgem under the net zero pre-construction work and small net zero projects reopener to carry out the feasibility phase of ProjectUnion.



DEC 16 – ProjectUnion Feasibility Phase Reopener Submission

JAN 13 – SQS Recieved

FEB 17 – Consultation Open

MAR 17 – Consultation Closed

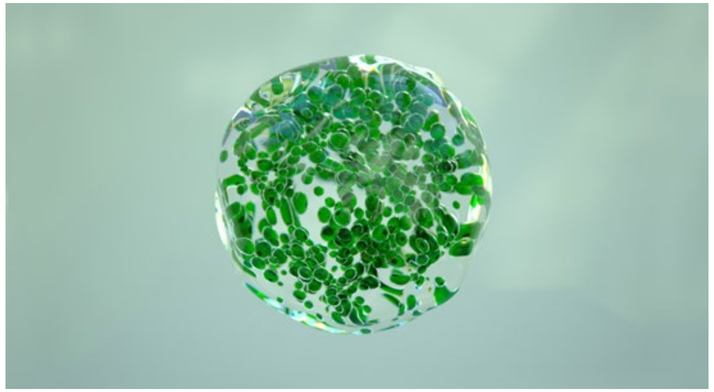
APR 25 – Decision

£5.626M* Funding under NZASP Reopener Mechanism

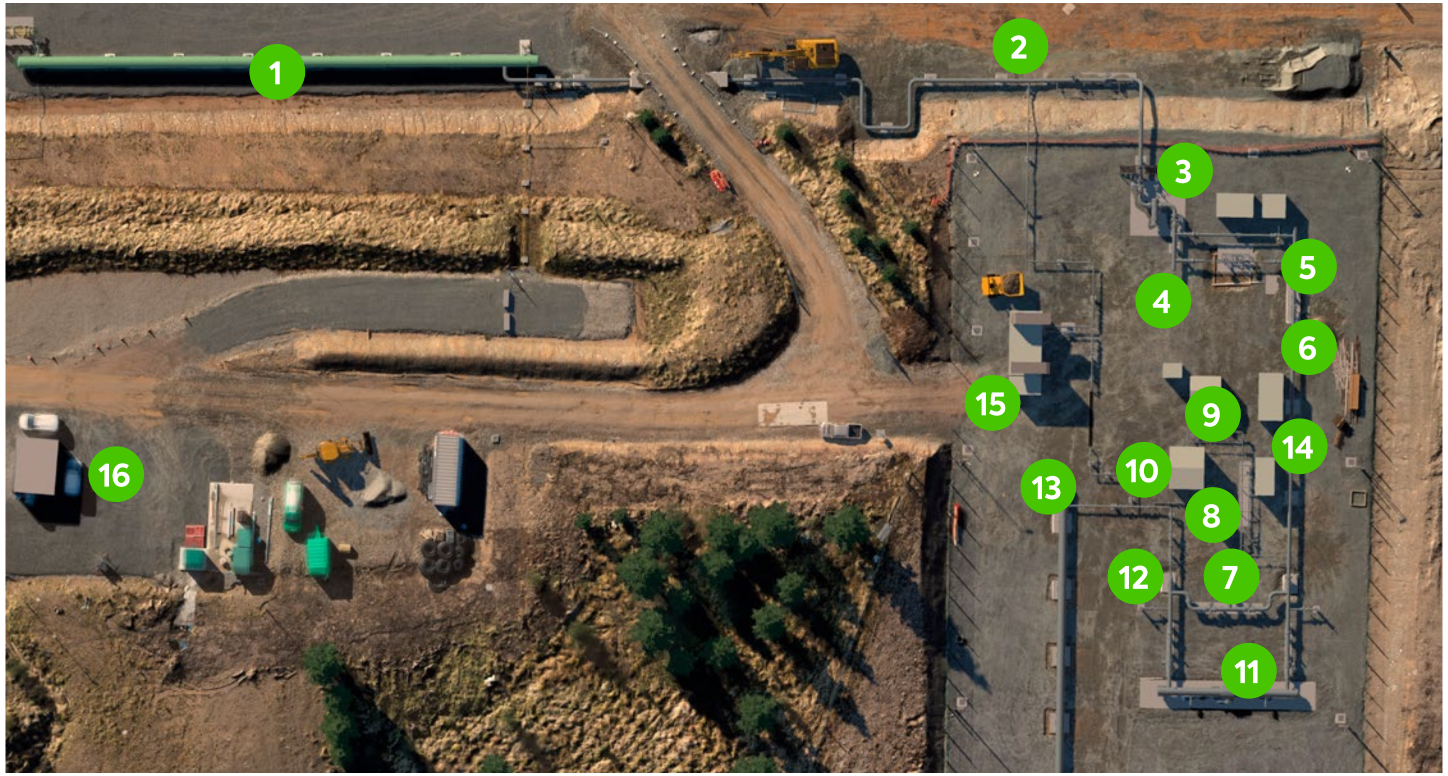
£0.625M* Additional Contribution Required

3.13 FutureGrid

FutureGrid is an ambitious programme building a hydrogen test facility from decommissioned assets at DNV's facility in Cumbria, to demonstrate the National Transmission System (NTS) can transport hydrogen.



Scan the QR code to see a virtual fly through of the FutureGrid facility



Key

1. High pressure storage
2. Ball valve arrangement
3. Filter
4. Ultrasonic meters
5. Flow control valve
6. Non-return valve
7. Filter skid
8. Orifice plate meters
9. Boiler House and heat exchange
10. Regulator skid
11. Pipeline isolation valve
12. Flow control valve
13. Low pressure storage
14. Metering and gas quality kiosks
15. Recompression unit
16. FutureGrid control room

3.13 FutureGrid

The FutureGrid testing plan

The main test programme will focus on evaluating the performance characteristics of the most common type of pipe (36"x60") as well as the class rating of the different assets (e.g. valves, filters). Each hydrogen concentration will be tested in the facility for 4 weeks, operating at seven different flow rates in order to generate conditions seen on the NTS.

2% hydrogen in natural gas

The first hydrogen blend that will flow through the FutureGrid facility will be 2% mixed with 98% natural gas. This is due to the market foreseeing the introduction of smaller scale blends while production begins to scale up. This creates demand for hydrogen produced and enables changes to Gas Safety (Management) Regulations, to be made which allows blending on the NTS.

5% hydrogen in natural gas

A 5% hydrogen blend with 95% natural gas is the next testing phase. The potential for variable hydrogen blends in the early stages of blending requires a safety margin. A 2% blend would likely be the first, so a 5% blend would provide a safety margin.

20% hydrogen in natural gas

The last blend is 20% hydrogen with 80% natural gas. This has been chosen because it represents the highest level of blending that existing consumer appliances can handle without modification. This may dictate the maximum blend compatible with the NTS without needing modification.

* The facility will pause testing at 10% hydrogen in natural gas to allow for asset calibrations.

100% hydrogen

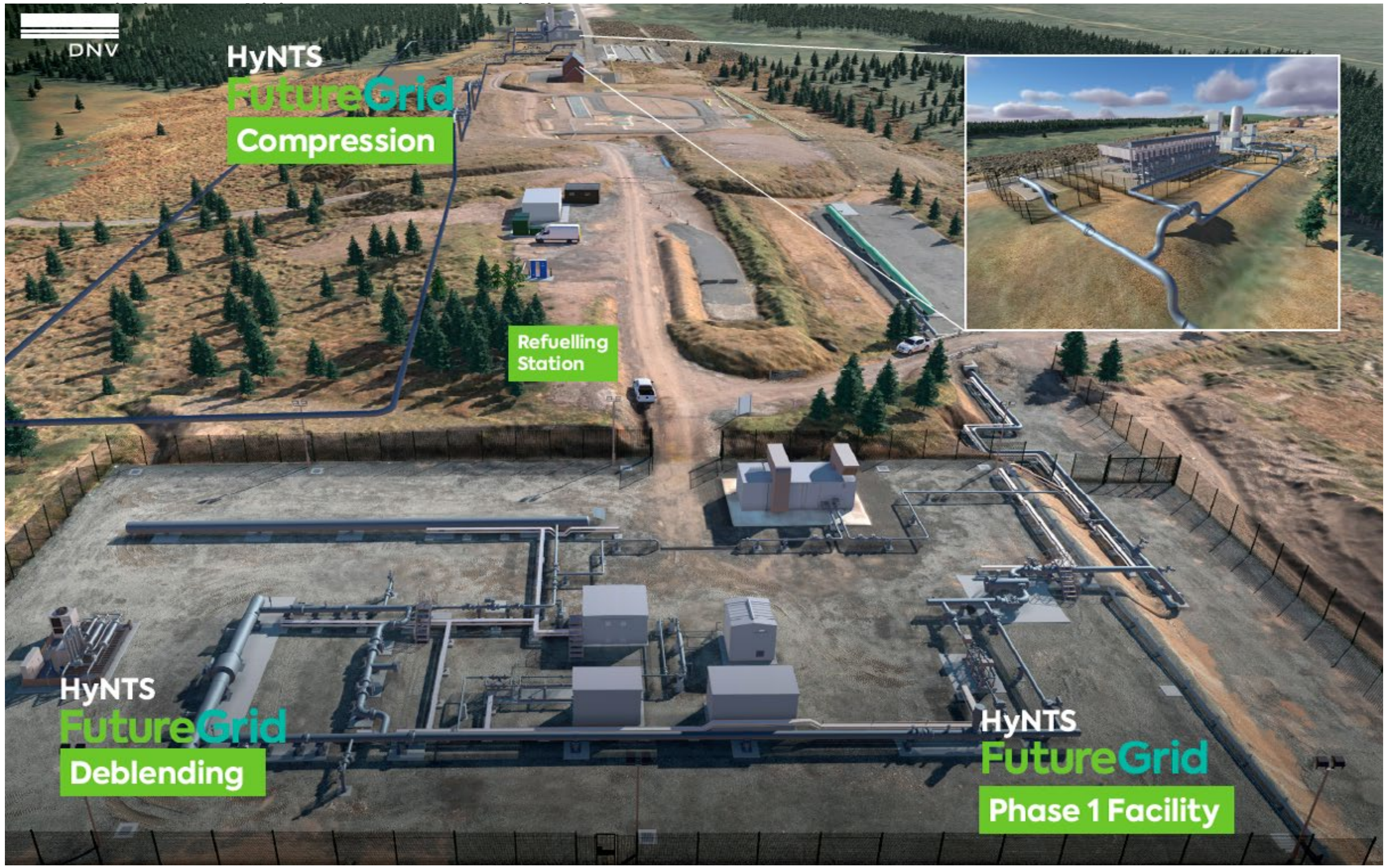
The final test will use flows of 100% hydrogen and no natural gas. Repurposing our network with 100% hydrogen will further our understanding of working with hydrogen and how it interacts with our assets. This will enable the development of appropriate processes, procedures, and safety standards, which are required to operate our network safely.

The recompression unit generates gas flows around the facility and has been designed for the FutureGrid facility. It allows us to simulate various flows across the facility that are representative of our network.

The various tests that will be performed across the facility are routinely carried out by technicians working on our network.

Throughout the testing we will be concentrating on vibration, noise, and permeation across the facility. The leak monitoring that will be completed will be compared to natural gas.

3.13 FutureGrid



4 Contact us

Continuing the conversation

Continuing the conversation

Your feedback is really important to us.

Letting us know what you think of the information we share with you, and how we're sharing it, helps us shape our future communications to ensure we're communicating what matters most, in a way that suits you.

Email us with your views and feedback on our publications at: .Box.OperationalLiaison@nationalgrid.com

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Appendices/ supporting information

Appendix 1 – Useful links

1.1.1 Capacity

- Capacity methodology statements | National Grid Gas Transmission
- Capacity | National Grid Gas Transmission
- Disconnections | National Grid Gas Transmission
- Entry capacity | National Grid Gas Transmission
- Reserving capacity (PARCA and CAM) | National Grid Gas Transmission
- Exit capacity | National Grid Gas Transmission

1.1.2 Connections

- Our RIIO-2 re-opener applications (2021-2026) | National Grid Gas Transmission
- Connections | National Grid Gas Transmission
- Connection application process overview | National Grid Gas Transmission
- Connecting to the NTS – overview and guidance | National Grid Gas Transmission
- Statement for Gas Transmission Connection Charging | National Grid Gas Transmission
- National Grid Connections Portal | National Grid Gas Transmission
- Constraint management | National Grid Gas Transmission

1.1.3 NTS route maps

- Network Route Maps | National Grid Gas Transmission

1.1.4 Other publications

- ANCAR | National Grid Gas Transmission
- Gas Future Operability Planning (GFOP) | National Grid Gas Transmission
- Connections document library | National Grid Gas Transmission

Appendix 2.1 Network capability zones

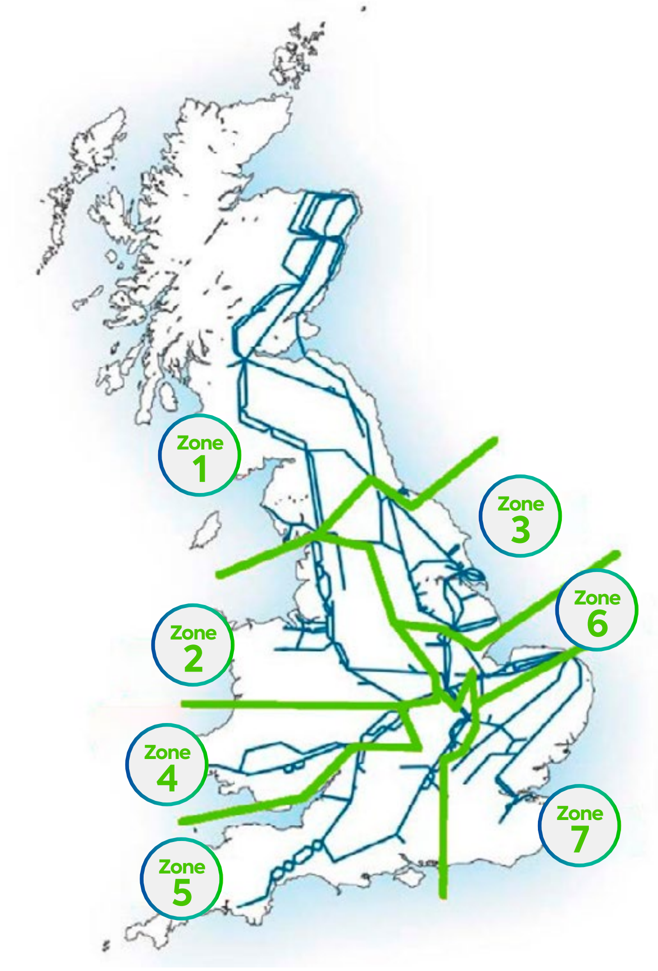
The National Transmission System (NTS) is a complex system of physical assets such as pipes, compressors, valves, supply points and offtakes. In order to simplify this, the analysis of the NTS has been partitioned into zones that correspond to the way in which gas flows through it. Figure A2.1 gives a simplified view of the NTS and the zones.

To assess both entry and exit capability, the NTS has been divided into seven zones:

- Zone 1: Scotland and the North
- Zone 2: North West
- Zone 3: North East
- Zone 4: South Wales
- Zone 5: South West
- Zone 6: East Midlands
- Zone 7: South East.

East Midlands and South West do not have sufficient entry points to include these in the entry capability assessment, so are omitted.

Figure A2.1
Network capability entry and exit zones.



Appendix 2.2 Network capability visualisations

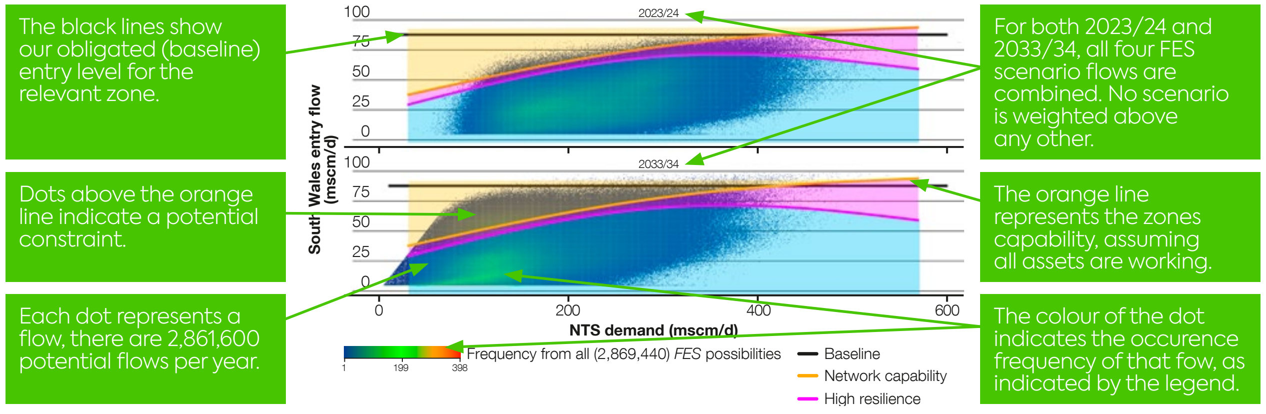
Figure A2.2

The visualisation of the network capability is an evolving attempt to explain network capability and its future requirements. The vertical axis reflects the absolute level of entry flow for the zone under consideration. The horizontal axis reflects the assumed pattern of national demand.

We analyse capability at a minimum of three different demand levels, Summer (low demand), Winter (high demand) and a midpoint demand. By interpolating these points we create network capability curves. As each of the Future Energy Scenarios are equally plausible, and broadly similar for the next decade, we have combined all the flow data for the year 2023/24 into one heatmap and the flow data for 2033/34 into a second heatmap.

Figure A2.2 gives an explanation of what we show on the network capability charts. For exit we do not use a line but instead a single figure per zone which is the 1-in-20 peak demand day level. This aligns closely with our Pipeline Security Standard obligation, and the exit design criteria for the NTS.

Figure A2.2
Entry network capability visualisation.



Appendix 2.3 Scotland and the North (zone 1)

Figure A2.3
Figure A2.4

Figure A2.3
Scotland and the North entry heatmap 2023/24 and 2033/34.

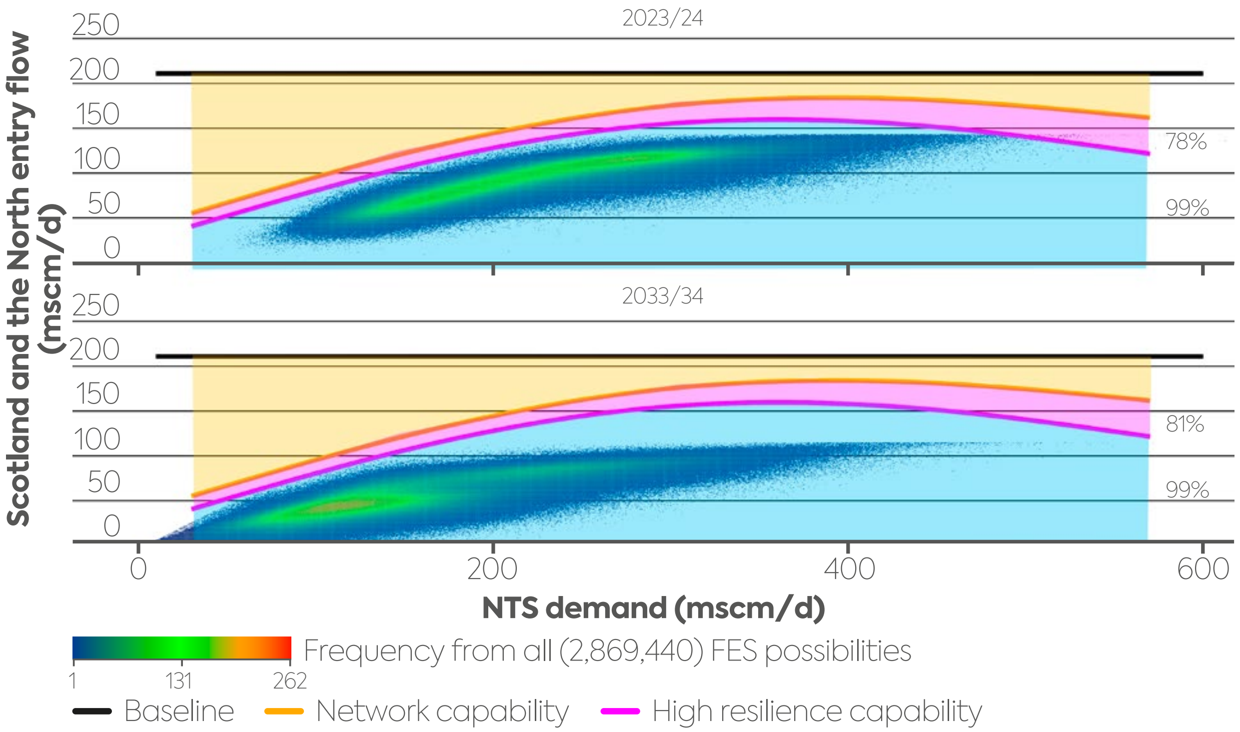
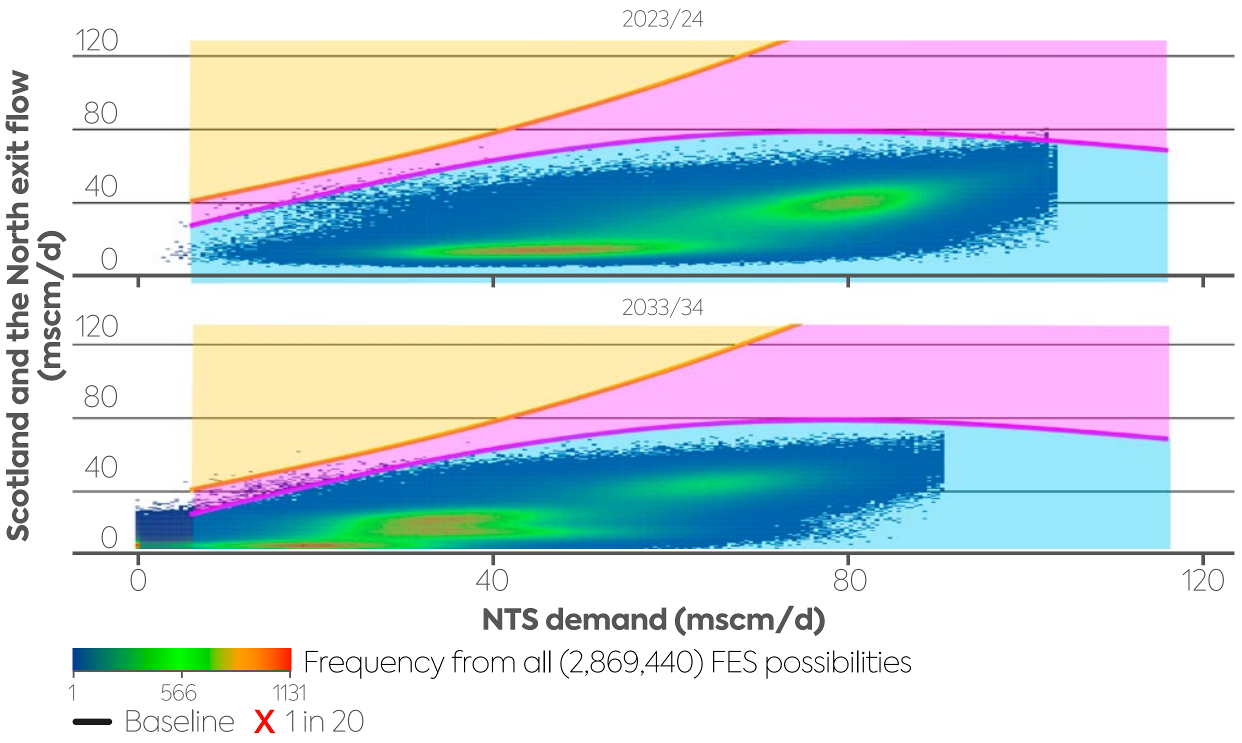


Figure A2.4
Scotland and the North exit heatmap 2023/24 and 2033/34.



Appendix 2.4 North West (zone 2)

Figure A2.5
Figure A2.6

Figure A2.5
North West entry heatmap 2023/24 and 2033/34.

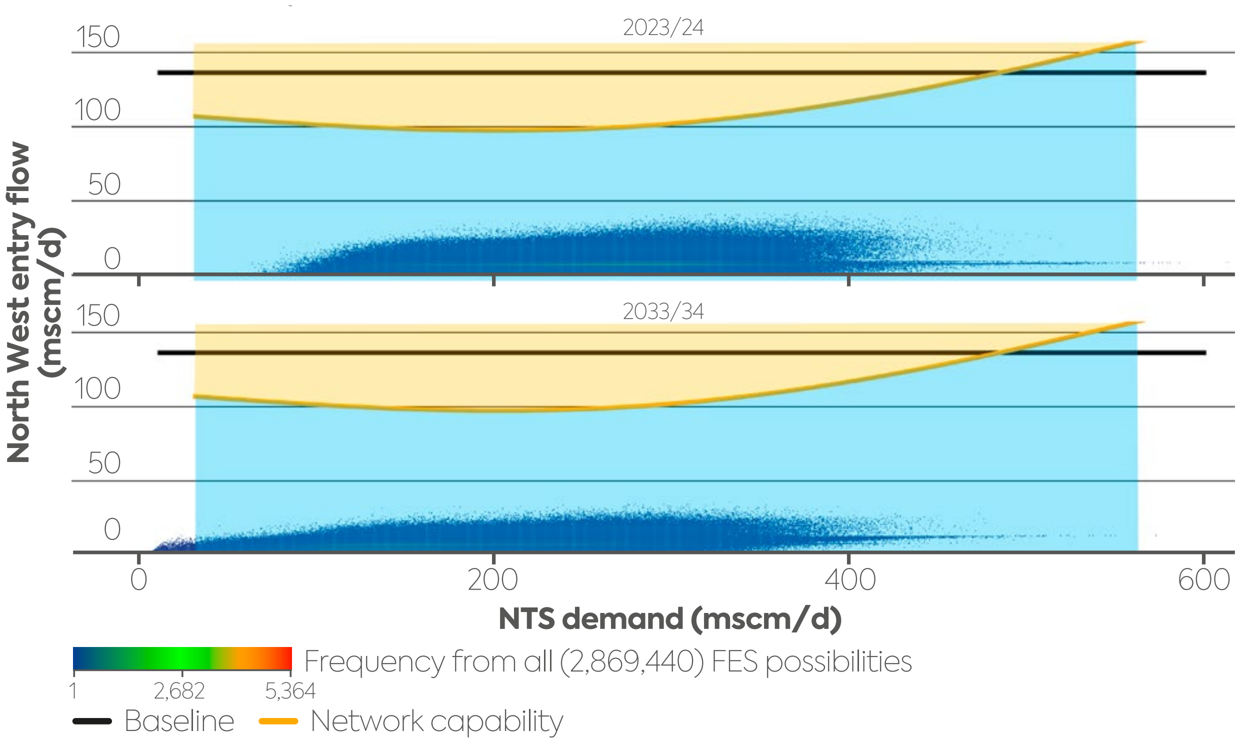
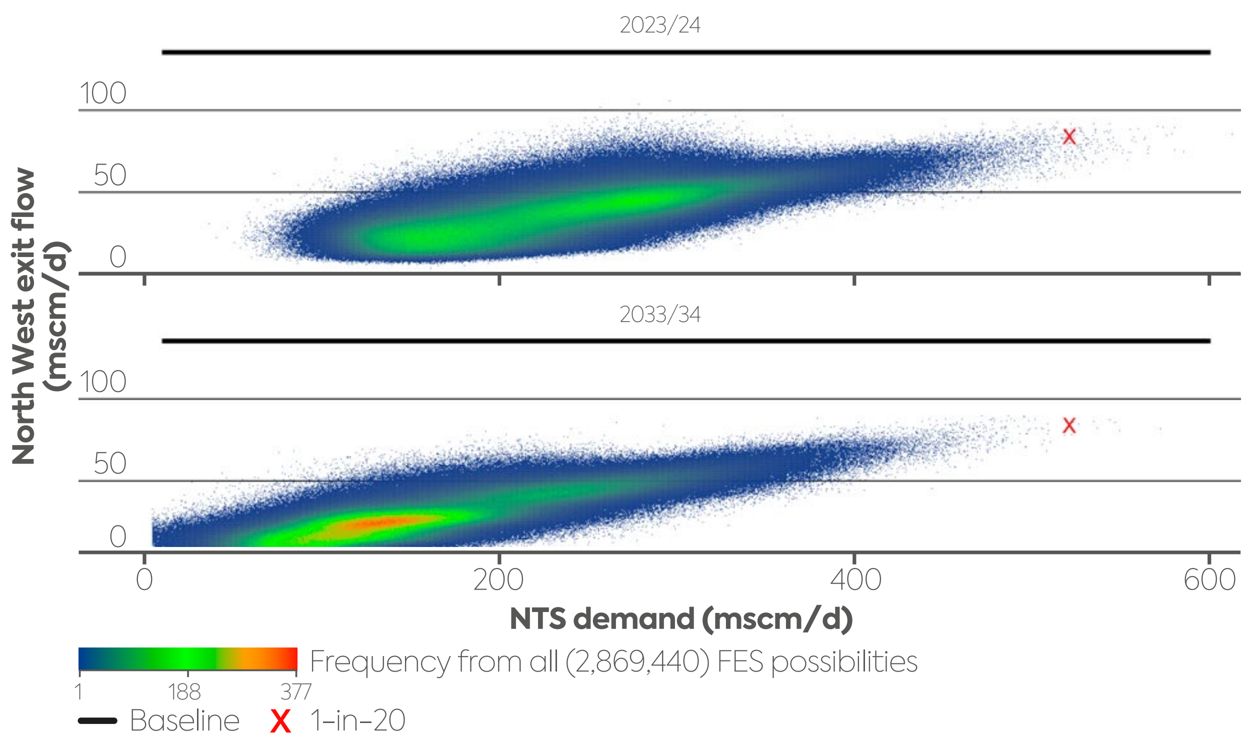


Figure A2.6
North West exit heatmap 2023/24 and 2033/34.



Appendix 2.5 North East (zone 3)

Figure A2.7
Figure A2.8

Figure A2.7
North East entry heatmap 2023/24 and 2033/34.

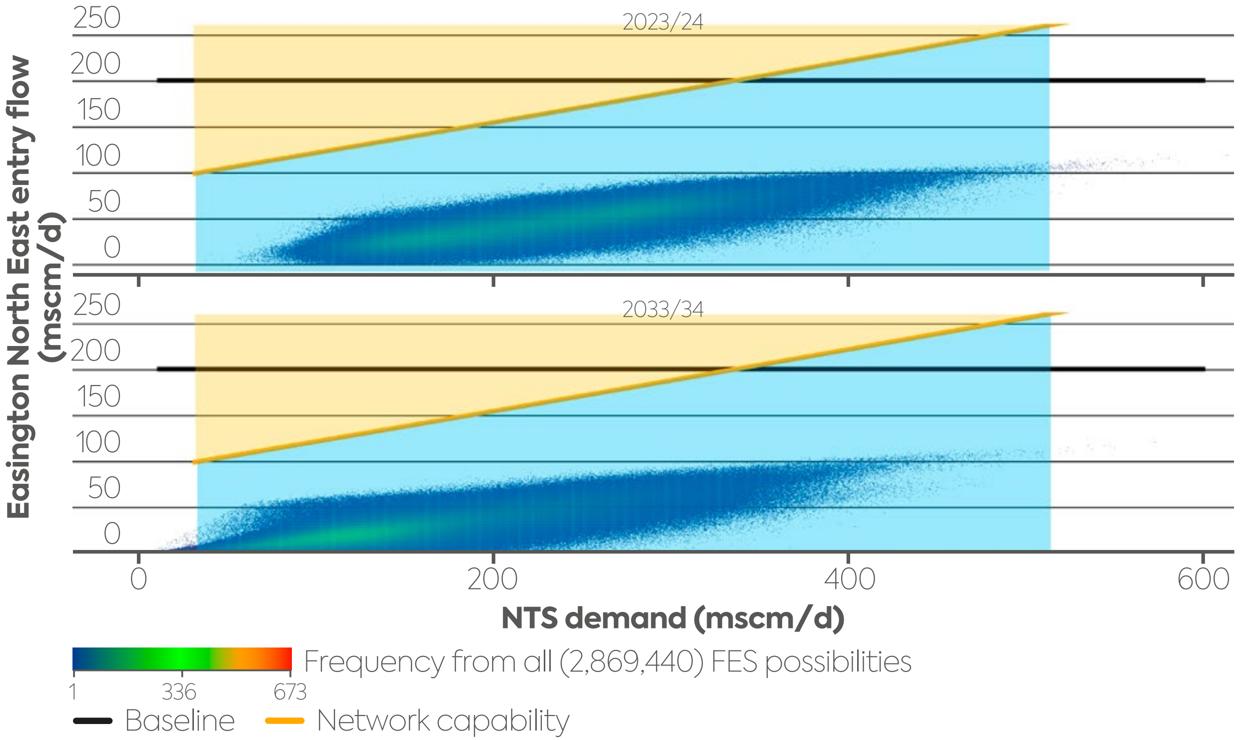
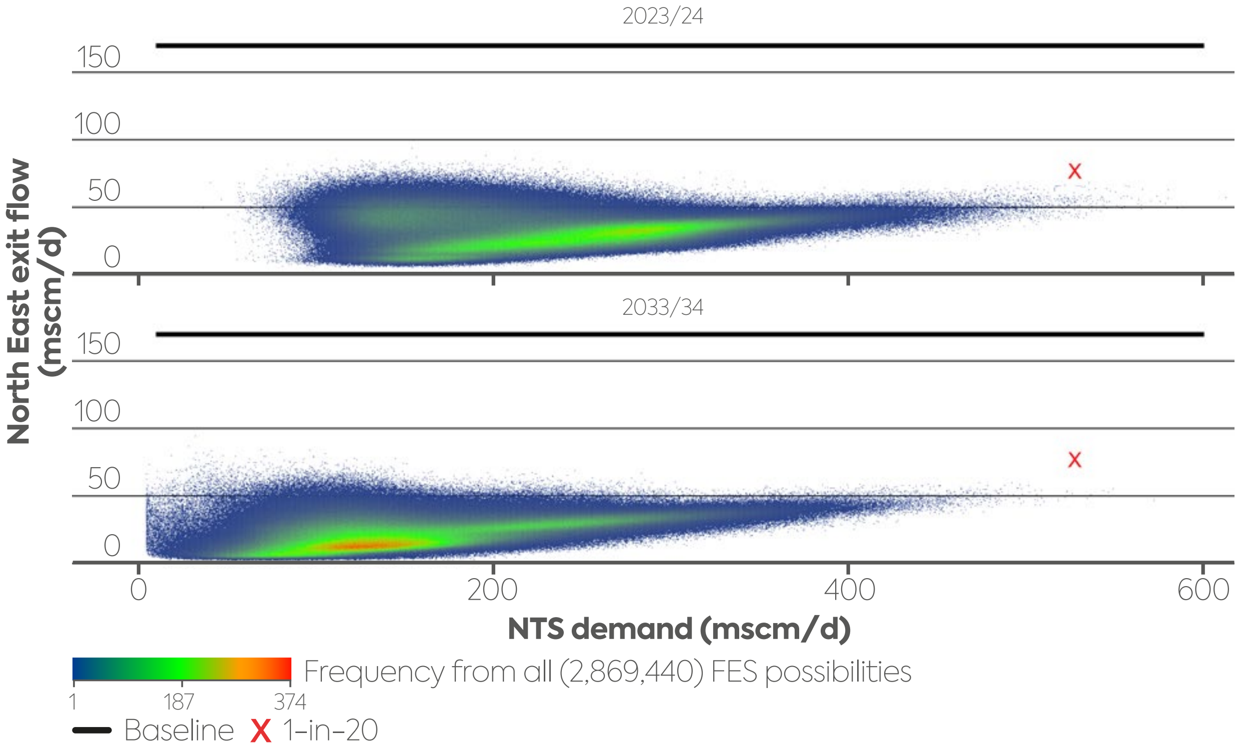


Figure A2.8
North East exit heatmap 2023/24 and 2033/34.



Appendix 2.6 South Wales (zone 4)

Figure A2.9
Figure A2.10

Figure A2.9
South Wales entry heatmap 2023/24 and 2033/34.

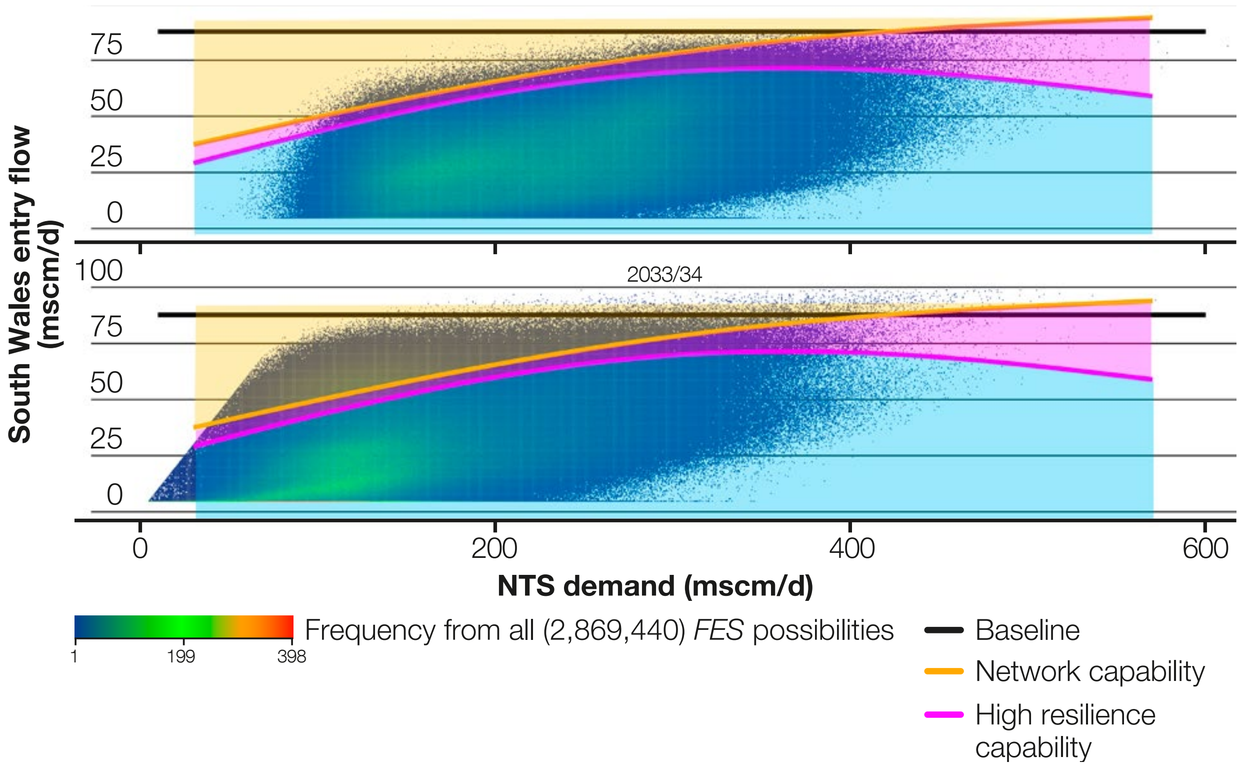
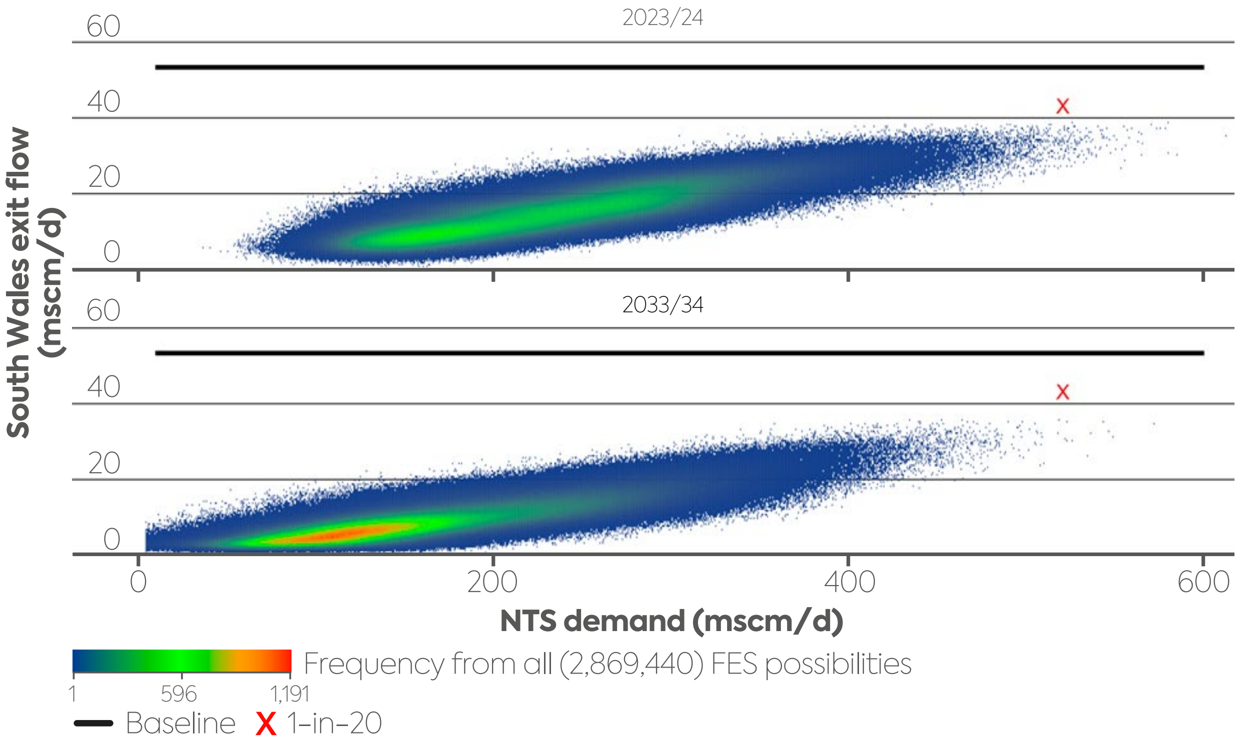


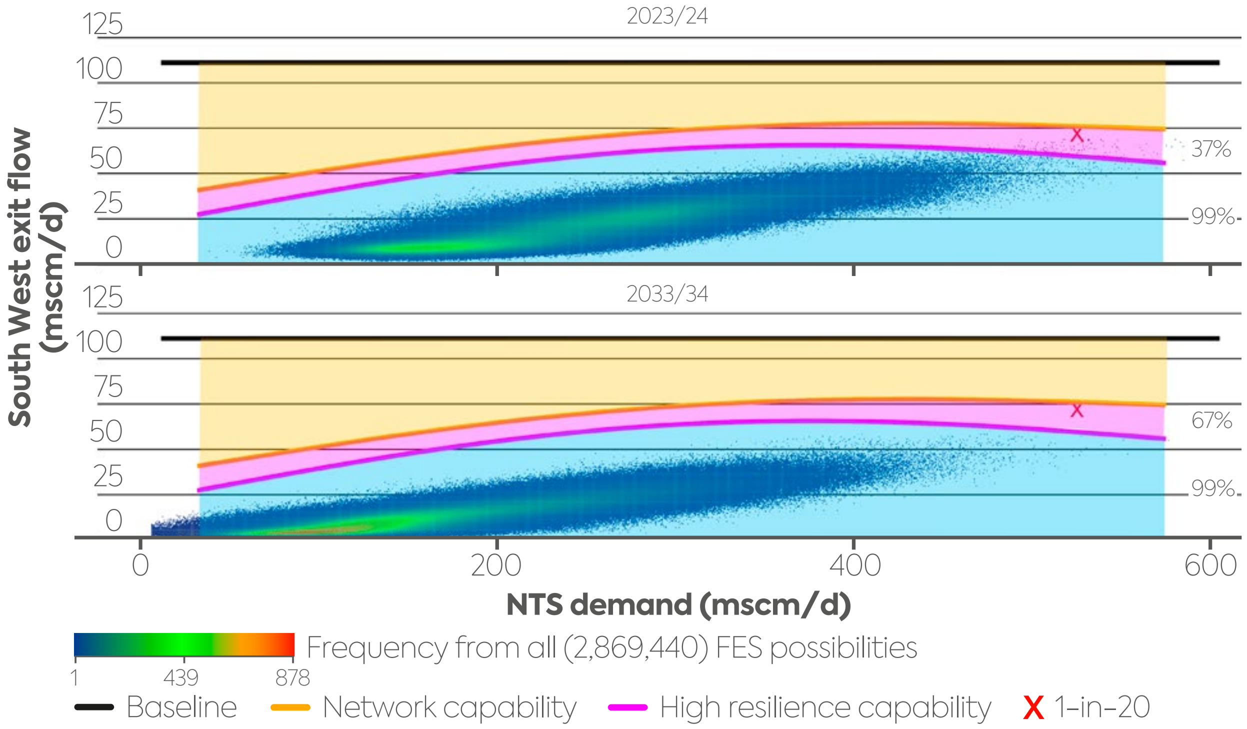
Figure A2.10
South Wales exit heatmap 2023/24 and 2033/34.



Appendix 2.7 South West (zone 5)

Figure A2.11

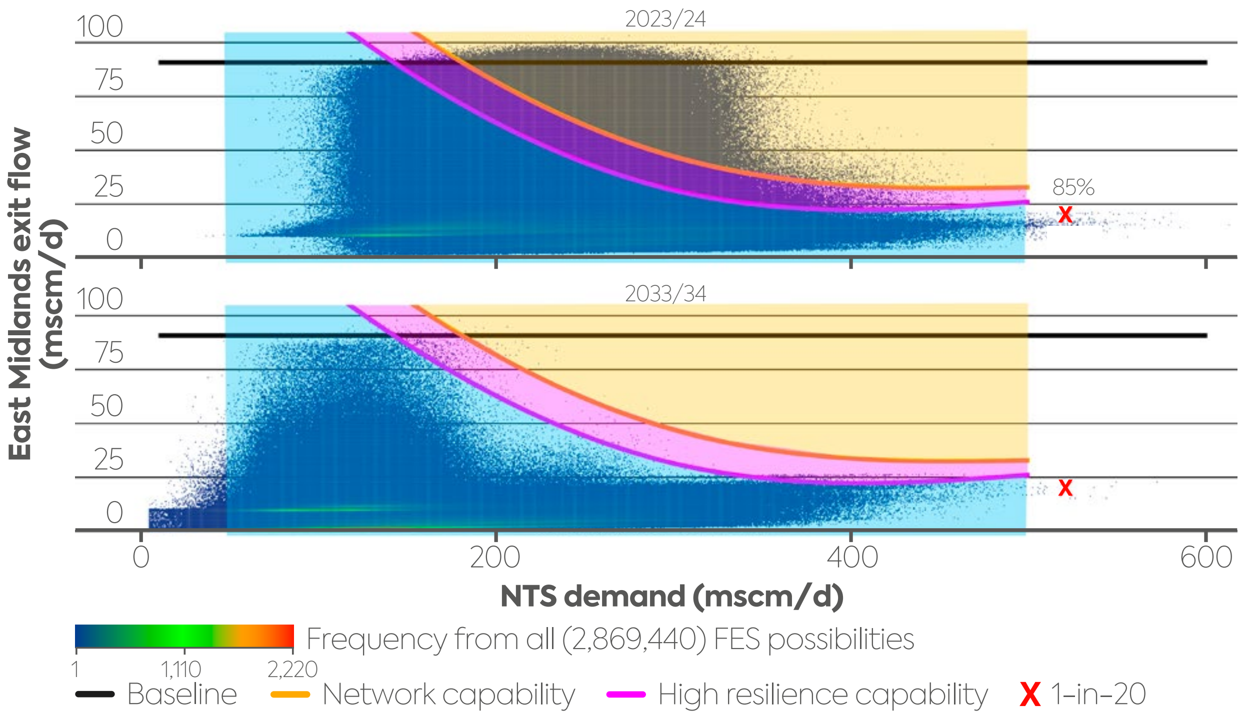
Figure A2.11
South West exit heatmap 2023/24 and 2033/34.



Appendix 2.8 East Midlands (zone 6)

Figure A2.12

Figure A2.12
East Midlands exit heatmap 2023/24 and 2033/34(standard FES).



Appendix 2.9 South East (zone 7)

Figure A2.13
Figure A2.14

Figure A2.13
South East entry heatmap 2023/24 and 2033/34.

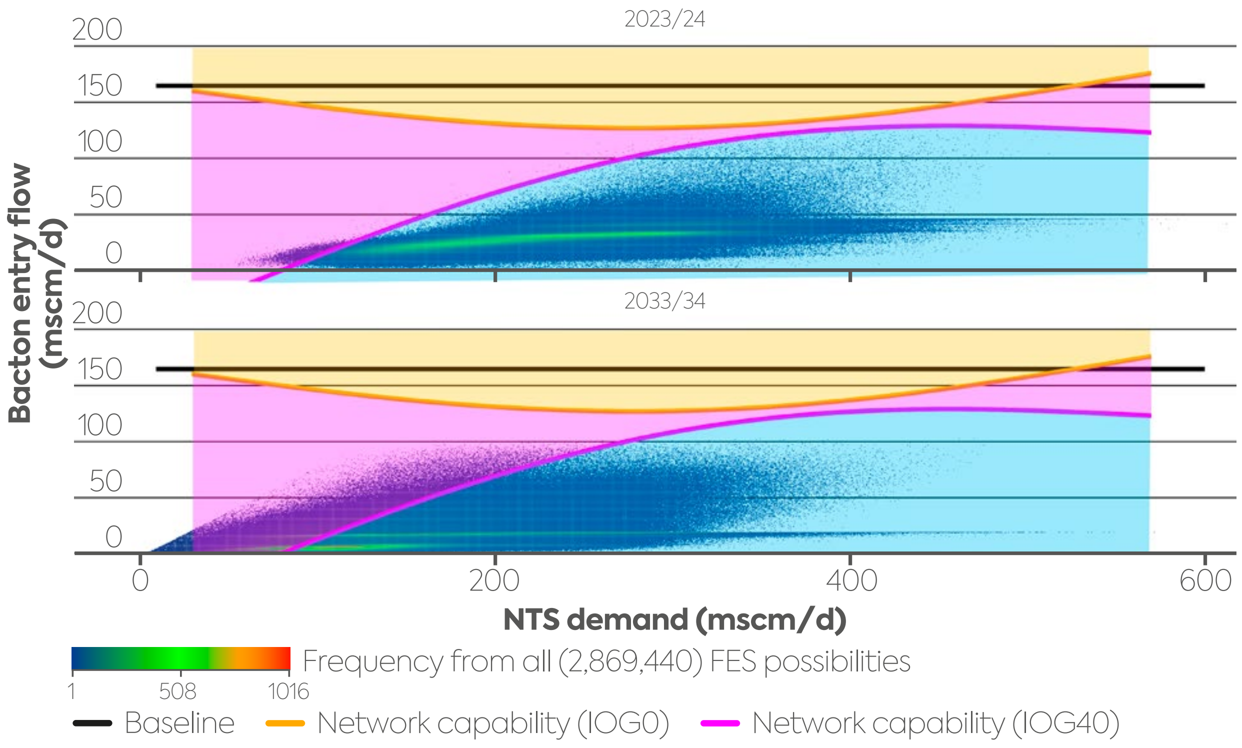
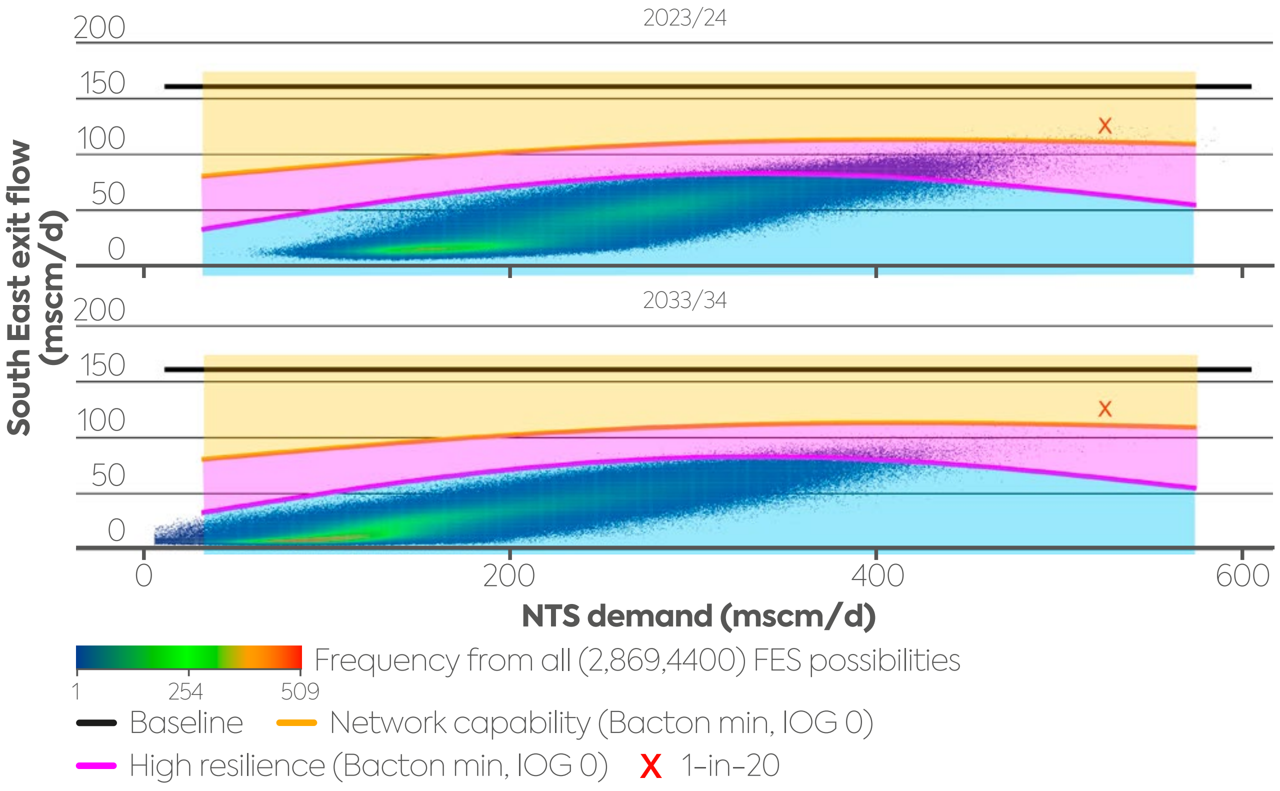


Figure A2.14
South East exit heatmap 2023/24 and 2033/34.



Appendix 3.1 Exit capacity maps

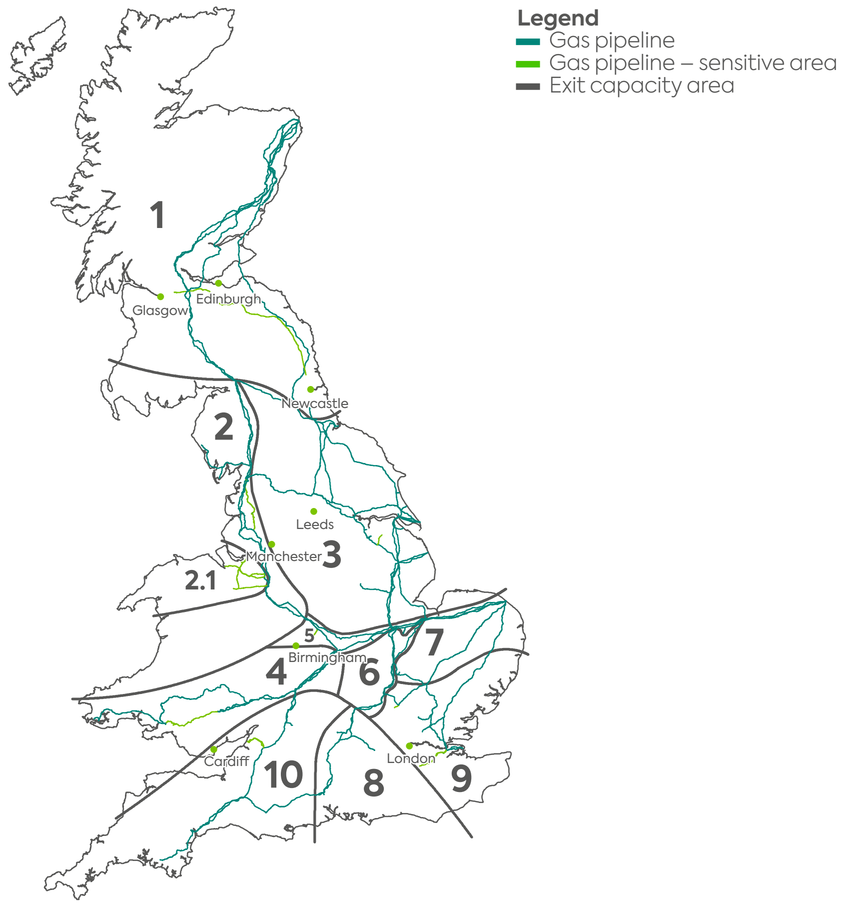
The NTS exit capacity map divides the NTS into zones based on key compressor stations, and multi-junctions (figure A3.1). These zones are purely for information and were created for the GTYS.

Within these zones, any new connection and/or capacity request is likely to be met through capacity substitution within the zone. All of our substitution analysis is carried out to the substitution methodology statement rules and while it is very likely that capacity will be substituted from within a zone, it is not guaranteed. In the following section we have provided a commentary explaining the potential capacity lead times and likelihood of substitution in each zone, including areas of sensitivity.

This information is an indication, and actual capacity lead times and availability will depend on the quantity of capacity requested from all customers within a zone and interacting zones.

This information recognises the impact Electricity Market Reform may have on interest in NTS connections and capacity.

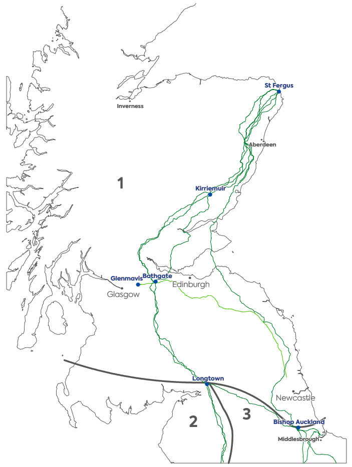
Figure A3.1
NTS exit capacity map.



Appendix 3.1 Exit capacity maps

Figure A3.2
Figure A3.3

Figure A3.2
Region 1 – Scotland and the North.



Legend
- Key sites
- Gas pipeline
- Gas pipeline – sensitive area
- Exit capacity area

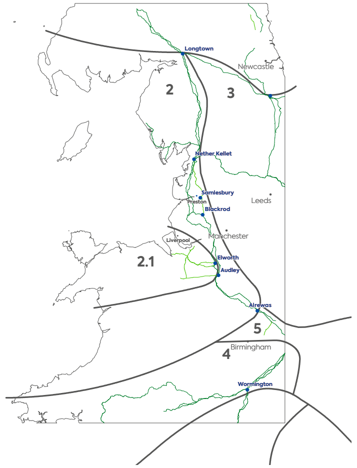
NTS location:
North of Longtown and Bishop Auckland

NTS/DN exit zones:
SC1, 2, 3, 4, NO1, 2

This region is sensitive to St Fergus flows. High St Fergus flows mean that exit capacity will be available, as flows from the St Fergus terminal are predominately in a north to south direction. As St Fergus flows reduce, exit capacity will be constrained.

There is only a small quantity of substitutable capacity in the area, but compressor flow modifications, including reverse flow capability, can be delivered to provide significant quantities of capacity without requiring Planning Act timescales. Capacity may be more limited in the sensitive area (Feeder 10 Glenmavis to Saltwick) due to smaller diameter pipelines.

Figure A3.3
Region 2 – North West and West Midlands (North).



Legend
- Key sites
- Gas pipeline
- Gas pipeline – sensitive area
- Exit capacity area

NTS location:
South of Longtown, north of Alrewas and east of Elworth

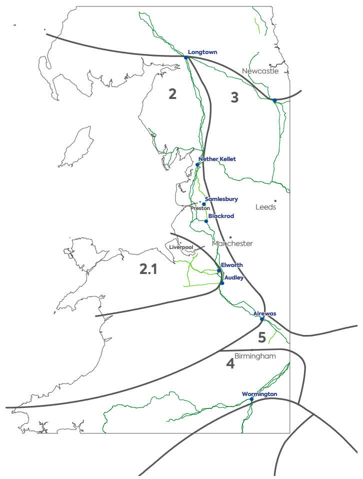
NTS/DN exit zones:
NW1, WM1

This region is highly sensitive to national supply patterns and use of storage; this area was historically supplied with gas from the North but increasingly receives gas from the South and from the East across the Pennines. The amount of unsold capacity in the region indicates that capacity could be made available by exit capacity substitution. A capacity request in zone 2 is likely to be met through substitution from zone 2, including zone 2.1, and then from the downstream zones, in this case zone 5. Capacity is likely to be available on the main feeder sections between Carnforth and Alrewas. Potential non-Planning Act reinforcements could release capacity, but then significant pipeline reinforcement would be required, particularly in the sensitive regions between Nether Kellett and Blackrod on Feeder 11.

Appendix 3.1 Exit capacity maps

Figure A3.4
Figure A3.5

Figure A3.4
Region 2.1 – North Wales and Cheshire.



Legend
- Key sites
- Gas pipeline
- Gas pipeline – sensitive area
- Exit capacity area

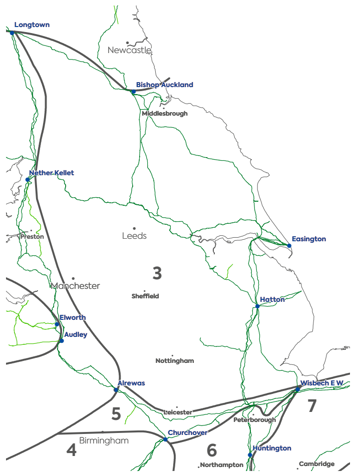
NTS location:
West of Elworth and Audley (Feeder 4)

NTS/DN exit zones:
NW2, WA1

This is an extremity of the system with limited local supplies (Burton Point) and a significant number of storage facilities.

The quantity of unsold capacity within the region indicates a good probability that capacity could be made available via exit capacity substitution. However, this would be available at direct connect offtakes where capacity can be booked. Potential non-Planning Act reinforcements could release small amounts of additional capacity, but significant pipeline reinforcement would be required, resulting in long (Planning Act) timescales.

Figure A3.5
Region 3 – North East, Yorkshire and Lincolnshire.



Legend
- Key sites
- Gas pipeline
- Gas pipeline – sensitive area
- Exit capacity area

NTS location:
South of Bishop Auckland, north of Peterborough and Wisbech and east of Nether Kellet

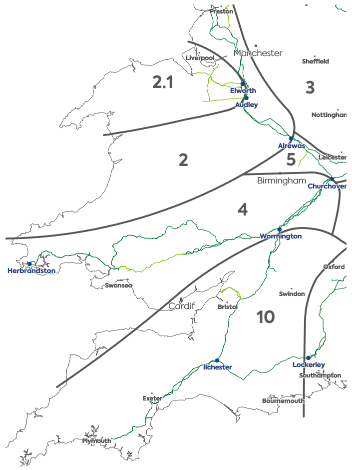
NTS/DN exit zones:
NE1, 2, EM1, 2

There are numerous power stations in this region and this may impact on future ramp rate agreements. The amount of unsold capacity in the region indicates that capacity could be made available through exit capacity substitution. Further capacity should be available without needing reinforcement, assuming stable north-east supplies; however, this may be limited on smaller diameter spurs, including between Brigg and Blyborough on Feeder 7. Non-Planning Act reinforcements, including compressor modifications, could be carried out to make additional capacity available.

Appendix 3.1 Exit capacity maps

Figure A3.6
Figure A3.7

Figure A3.6
Region 4 – South Wales and West Midlands (South).



Legend
- Key sites
- Gas pipeline
- Gas pipeline – sensitive area
- Exit capacity area

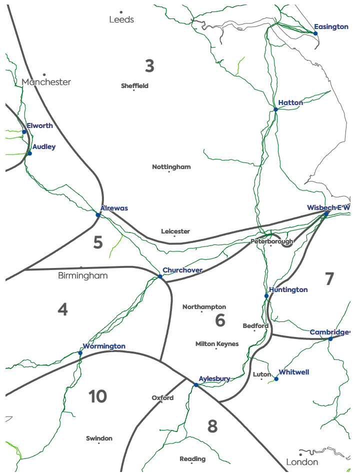
NTS location:
West of Churchover

NTS/DN exit zones:
WM3, SW1, WA2

Exit capacity availability is highly sensitive to Milford Haven flows. Low Milford Haven flows result in reduced South Wales pressures, which limit capacity.

High Milford Haven flows result in reduced pressures in the West Midlands which may limit capacity. Potential non-Planning Act reinforcements could release small quantities of capacity, but significant pipeline reinforcement would be required, particularly in the sensitive area on Feeder 2, south of Cilfrew between Dyffryn Clydach and Gilwern, due to the different pressure ratings.

Figure A3.7
Region 5 – Central and East Midlands.



Legend
- Key sites
- Gas pipeline
- Gas pipeline – sensitive area
- Exit capacity area

NTS location:
South of Alrewas, north of Churchover, west of Wisbech

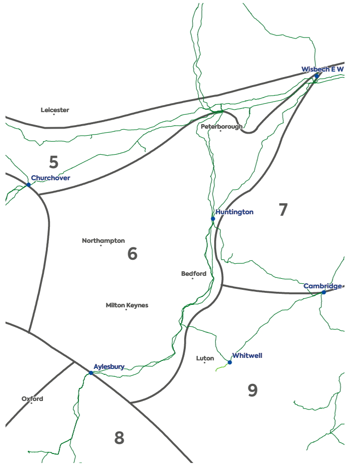
NTS/DN exit zones:
EM3, 4, WM2

The unsold capacity here indicates a limited scope for substitution. Potential non-Planning Act reinforcements could be carried out to release a small amount of capacity, but significant pipeline reinforcement would be required, particularly for the sensitive area on Feeder 14 between Austrey to Shustoke.

Appendix 3.1 Exit capacity maps

Figure A3.8
Figure A3.9

Figure A3.8
Region 6 – Peterborough to Aylesbury.



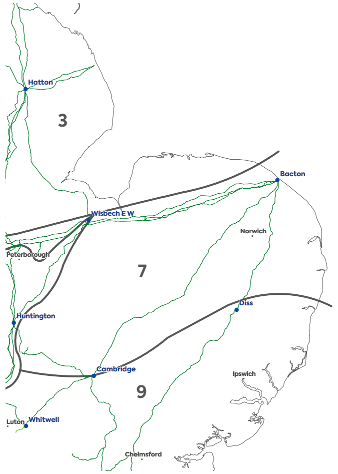
Legend
- Key sites
- Gas pipeline
- Gas pipeline – sensitive area
- Exit capacity area

NTS location:
North of Aylesbury, south of Peterborough and Wisbech, west of Huntingdon

NTS/DN exit zones:
EA6, 7

Capacity availability is sensitive to demand increases downstream in region 10, the South West. The quantity of unsold capacity indicates limited scope for exit capacity substitution from the single offtake in the region, but there may be scope for substitution from the southern region downstream of Aylesbury. Potential non-Planning Act reinforcements could be carried out to release capacity.

Figure A3.9
Region 7 – Norfolk.



Legend
- Key sites
- Gas pipeline
- Gas pipeline – sensitive area
- Exit capacity area

NTS location:
North of Diss and Cambridge, east of Wisbech

NTS/DN exit zones:
EA1, 2, 3

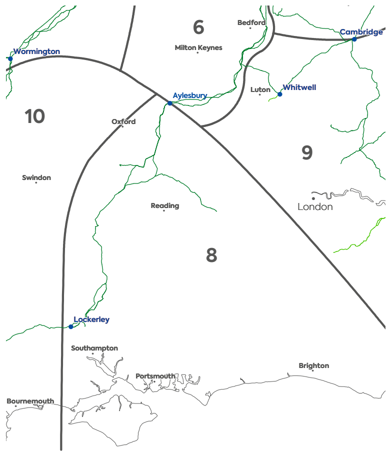
This region is sensitive to South East demand; if demand increases in the South East, capacity may become more constrained.

Unsold capacity here indicates a good probability that capacity could be substituted. Additional capacity could be made available without reinforcement works, assuming stable Bacton supplies.

Appendix 3.1 Exit capacity maps

Figure A3.10
Figure A3.11

Figure A3.10
Region 8 – Southern.



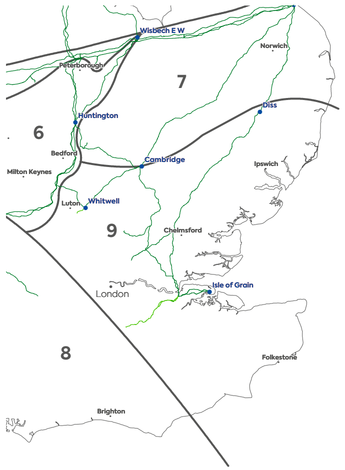
Legend
- Key sites
- Gas pipeline
- Gas pipeline – sensitive area
- Exit capacity area

NTS location:
South of Aylesbury and north of Lockerley

NTS/DN exit zones:
SO1, 2

The region is sensitive to demand in the South West; if demand increases, capacity may become more constrained. The amount of unsold capacity indicates a good chance that capacity could be made available via exit capacity substitution. Potential non-Planning Act reinforcements (compressor station modifications) could release a small amount of capacity.

Figure A3.11
Region 9 – London, Suffolk and the South East.



Legend
- Key sites
- Gas pipeline
- Gas pipeline – sensitive area
- Exit capacity area

NTS location:
South Diss, Cambridge, east of Whitwell

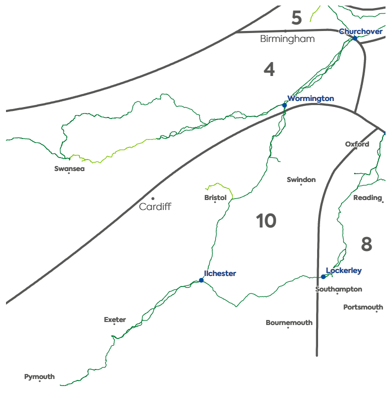
NTS/DN exit zones:
EA4, 5, NT1, 2, 3, SE1, 2

The region is sensitive to Isle of Grain flows, with low flows limiting capacity. Capacity may be more limited in the sensitive areas at the extremities of the system, for example at Feeders 5 and 18 from Shorne to Tatsfield, and Feeder 3 from Whitwell to Peters Green. The significant number of power stations in the region may impact on future ramp rate agreements. Unsold capacity indicates some capacity could be made available via exit capacity substitution; however, exchange rates may vary between locations. Potential non-Planning Act reinforcements could be carried out to release small quantities of additional capacity but significant pipeline reinforcement would be needed.

Appendix 3.1 Exit capacity maps

Figure A3.12

Figure A3.12
Region 10 – South West.



Legend
- Key sites
- Gas pipeline
- Gas pipeline – sensitive area
- Exit capacity area

NTS location:
South of Wormington and Lockerley

NTS/DN exit zones:
SW2, 3

Although the quantity of unsold capacity in this region indicates scope for capacity being made available through exit capacity substitution, exchange rates may be high ue to small diameter pipelines. Potential non-Planning Act reinforcements could release small quantities of additional capacity, but significant pipeline reinforcement would be needed, resulting in long (Planning Act) timescales, particularly in the sensitive area from Pucklechurch to Seabank on the Feeder 14 spur due to small diameter pipelines. There is also sensitivity to low Milford Haven flows. During peak demand with low Milford Haven flows it becomes more difficult to maintain assured pressures in the South West.

Appendix 4.1 Gas quality developments

The review of the Gas Safety (Management) Regulations 1996 (GS(M)R) was completed this year, with the publication of HSE's consultation response and final impact assessment on 10 March 2023. CD291 – Revision of the Gas Safety (Management) Regulations 1996 – Health and Safety Executive – Citizen Space (hse.gov.uk)

As a result of this review, changes to the UK gas quality specification within the GS(M)R that came into force from 6 April 2023 in the The Gas Safety (Management) (Amendment) Regulations 2023 are as follows:

- removal of the Incomplete Combustion Factor (ICF) and Soot Index parameters
- introduction of a 0.7 Relative Density limit
- increase to the permitted oxygen content on below 38 bar systems from 0.2mol% to 1.0mol%.

With effect from 6 April 2023, we therefore began to monitor gas quality compliance at all points at which gas enters the NTS based on the Relative Density parameter instead of ICF and Soot Index. As the need for these changes derived from a legal requirement, in accordance with UNC, they were deemed to be incorporated into the Network Entry Agreements, Interconnection Agreements and Storage Connection Agreements from this date and we are now seeking to agree and execute the necessary contractual amendments with each entry facility operator.

A further amendment to reduce the lower limit for Wobbe Index from 47.2 MJ/m^3 to 46.50 MJ/m^3 was approved by HSE. This shall enter into force from 6 April 2025 to allow additional time for impacted consumers to make any technical modifications to equipment that may be necessary to accommodate a potential wider Wobbe Index range.

We had previously engaged with operators that deliver gas into the NTS to establish which sites would want to implement a lower limit for Wobbe Index. Projections on the volumes and Wobbe Index that would be likely to be delivered were obtained from these operators which we used to produce network penetration analysis to provide an indication to exit customers of the locations on the network where lower Wobbe gas might be in the future.

We intend to bring forward a UNC Modification Proposal, including suitable transparency arrangements, to enable the implementation of this change to Wobbe Index from April 2025 for those entry operators that have requested it. One associated challenge is that the Bacton interconnectors are currently unable to accept gas with a Wobbe Index below the current lower limit of 47.2 MJ/m^3 when exporting to the continent due to specification constraints on the networks of continental TSOs. We are therefore working with the relevant TSOs on potential solutions to this issue prior to raising the enabling UNC Modification.

Other key changes implemented by the GS(M)R Review were to extend the duty of cooperation for entry terminals to specifically include LNG operators and extension of the requirement for a safety case to operators of biomethane pipelines.

Appendix 4.1 Gas quality developments

Gas quality data provision

We are also exploring the provision of additional gas quality data to the industry. This began with a Gas Markets Plan (GMaP) project and evolved into two workstreams; one looking at the requests from industry participants for National Gas to make additional gas quality data available based upon current technology and another, to commence at a future time, which will consider data requirements and technology required as we move through the energy transition and as hydrogen is introduced to the networks.

In relation to the former, we have worked with stakeholders to develop a project scope and have obtained inputs via a Request For Information to our exit customers, from which we have obtained stakeholder views both of what is required and why provision of such data would be beneficial.

Most recently, our focus has been to explore the feasibility of making gas quality data available to the industry that is measured at DN offtake points as a first step, recognising that securing such transparency at NTS entry points is expected to take longer to achieve.

Mercury specification

Following internal review and industry engagement, it has been determined to leave the mercury guidance limit at 10µg/m^3. Mercury is not directly stated in GS(M)R, but is covered indirectly in that the gas we transport "shall not contain solid or liquid material which may interfere with the integrity or operation of pipes or any gas appliance." The guidance limit of 10µg/m^3 has been set as this is typically specified for heat exchangers in industrial and power plant, and is considered a safe level in terms of metal works and combustion components.

Thank you to those who provided feedback and responded to our industry questionnaires.

Appendix 5.1 Import and storage infrastructure

Tables A5.1
Tables A5.2

Great Britain is served through a diverse set of import routes from Norway, the Netherlands, Belgium and from other international sources through the LNG import terminals. Total import capacity is currently around 144 bcm/year, split into three near equal parts: Continental Europe (42 bcm/year), Norway (51 bcm/year)[2] and LNG (51 bcm/year). Table A5.1 shows existing import infrastructure and table A5.2 shows proposals that we have been officially made aware of.

Please note

The figures in A5.1 and A5.3 represent the maximum capability indicated by the operators of these sites. For our winter outlook we include shorter term intelligence which can result in differences between the capability for the imports and storage.

Table A5.1
Existing import infrastructure.

Facility	Operator/Developer	Type	Location	Capacity (bcm/year)	Source
Interconnector	Interconnector Limited	Pipeline	Bacton	25.5	Link
BBL Pipeline	BBL Company	Pipeline	Bacton	16.4	Link
Isle of Grain 1-3	National Grid	LNG	Kent	21.4	Link
South Hook 1-2	Qatar Petroleum and ExxonMobil	LNG	Milford Haven	21.0	Link
Dragon 1	Shell/Petronas	LNG	Milford Haven	9.1	Link
Langeled	Gassco	Pipeline	Easington	26.3	Link
Vesterled	Gassco	Pipeline	St Fergus	13.5	Link
Tampen[3]	Gassco	Pipeline	FLAGS/St Fergus	9.1	Link
Gjoa[3]	Gassco	Pipeline	FLAGS/St Fergus	6.4	Link
			Total	**144.1**	

Table A5.2
Proposed import infrastructure.

Project	Operator/Developer	Type	Location	Capacity (bcm/year)	Status
Isle of Grain 4	National Grid	LNG	Kent	–	Open Season
South Hook 3	South Hook 3	LNG	Milford Haven	5.4 bcm	PARCA submitted

[2] Where quoted in GWh/d converted to bcm based on a CV of 39.6 MJ/m³

[3] Both Tampen and Gjoa connect to FLAGS pipeline offshore, this limits total capacity of these pipelines and any UKCS gas to around 11.0 bcm/y

Appendix 5.2 Storage infrastructure

Tables A5.3

In the last 12 months the most significant change to GB storage has been the expansion of the Rough facility. The following tables detail UK storage in terms of existing storage sites, those under construction and proposed sites.

Table A5.3
Existing storage infrastructure.

Site	Operator/Developer	Location	Space (bcm)	Approximate max delivery (mcm/d)
Aldbrough	SSE/Statoil	East Yorkshire	0.294	29.9
Hatfield Moor[4]	Scottish Power	South Yorkshire	0.112	1.8
Holehouse Farm[5]	EDF Trading	Cheshire	0.022	0.0
Holford	Uniper	Cheshire	0.240	21.9
Hornsea	SSE	East Yorkshire	0.309	6.4
Humbly Grove	Humbly Grove Energy	Hampshire	0.283	7.2
Hill Top Farm	EDF Energy	Cheshire	0.055	13.3
Rough	Centrica Storage	Southern North Sea	1.503	8.9
Stublach	Storengy	Cheshire	0.405	36.4
		Total	**3.223**	**125.7**

[4] Hatfield Moor Space data source: https://www.scottishpower.com/userfiles/file/Hatfield-Site-Information-2014.pdf
Hatfield Moor max delivery data source: https://www.scottishpower.com/pages/hatfield_moor_remit_active.aspx

[5] Data source: https://www.nationalgas.com/data-and-operations/transmission-operational-data#tab-3. Taken on 25/10/2023.

Appendix 5.2 Storage infrastructure

Tables A5.4

The economics, particularly the winter to summer spread, are very challenging for the development of new storage sites. Nevertheless, many new storage sites have been proposed over the past ten years and there are currently plans for nearly 9bcm of space, both for medium-range fast-cycle facilities and long-range seasonal storage.

Table A5.4
Proposed storage sites (Source: site operators).

Project	Operator/Developer	Location	Space (bcm)	Approximate max delivery (mcm/d)
Gateway	Stag Energy	Offshore Morecambe Bay	1.5	Planning granted, no FID
Deborah	Eni	Offshore Bacton	4.6	Planning granted, no FID
Islandmagee	InfrasStrata	County Antrim, Northern Ireland	0.5	Planning granted, no FID
King Street	King Street Energy	Cheshire	0.3	Planning granted, no FID
Preesall	Halite Energy	Lancashire	0.6	Planning granted, no FID
Saltfleetby	Wingaz	Lincolnshire	0.8	Planning granted, no FID
Whitehill	E.ON	East Yorkshire	0.4	Planning granted, no FID
		Total	**8.7**	

Please note

Tables A5.1, A5.2, A5.3 and A5.4 represent the latest publicly available information to National Grid at the time the GTYS went to press. Developers are welcome to contact us to assess or revise this data.

Glossary

List of glossary terms

Glossary

1-in-20 obligation
This is the highest level of gas demand that we should expect to experience only once in every 20 years. We are obliged to plan and develop the network to meet the 1-in-20 level.

Annual Network Capability Assessment Report (ANCAR)
This annual report contains an assessment of our Network Capability. Assessing our Network Capability enables us to calculate and demonstrate the physical capability of the NTS and how that capability compares to the needs of our customers now and into the future. This assessment is carried out against a range of future supply and demand scenarios using the Future Energy Scenario (FES) outputs produced by the Electricity System Operator (ESO). The output of this assessment helps inform potential changes to market rules, commercial tools or physical assets, to ensure continued safe and economic operation of the NTS in meeting our customers' needs.

Asset
Any physical part of the network and includes such things as compressors, pipelines, flow valves and regulators.

Asset Management Plan (AMP)
An AMP provides a view of how we will manage, maintain and invest in our assets in line with legislation and our regulatory requirements.

Bacton
Bacton manages a large volume of the nation's gas, and is a critical component of the gas transmission network now and going into the future. Bacton is a key dynamic swing node for a large subset of our customer base at an interdependent part of the network. In addition, Bacton bridges GB with EU via two interconnectors (BBL and IUK), and controls flows into the South East to ensure security of supply for London and the west–east transit route for LNG into Europe.

BBL (interconnector)
A bi-directional gas pipeline connecting Bacton in the UK and Balgzand in the Netherlands .

Bcm
Billions of cubic metres.

Capacity substitution
Whilst production of biomethane is growing rapidly worldwide, significant investment and innovation is still needed for it to become a major source of gas supply in the UK. The Chancellor's 2019 Spring Statement included new proposals to advance the decarbonisation of gas supplies by increasing the proportion of green gas in the grid, helping to reduce dependence on burning natural gas in homes and businesses. The consultation is expected to consider continued support for biomethane after funding for the Renewable Heat Incentive comes to an end in 2021.

Compressor
Compressors are used to move gas around the transmission network through high pressure pipelines. There are currently 71 compressors at 24 sites across the country. These compressors move the gas from entry points to exit points on the gas network. They are predominantly gas driven turbines that are in the process of being replaced with electric units.

Computerised Maintenance Management System (CMMS)
This is a digital support tool that helps inform decisions around the management and maintenance of our assets.

Constraint
A constraint is where the pressure or flow required to meet customer needs cannot be met by the physical capability of the network. On entry flame charts the potential of this is represented by a dot above the capability line.

Critical National Infrastructure (CNI)
The UK's Critical Infrastructure is defined by the UK government as: "Those critical elements of Infrastructure (facilities, systems, sites, property, information, people, networks and processes), the loss or compromise of which would result in major detrimental impact on the availability, delivery or integrity of essential services, leading to severe economic or social consequences or to loss of life.

Cyber Assessment Framework (CAF)
The Cyber Assessment Framework (CAF) provides guidance for organisations responsible for vitally important services and activities. The Cyber Assessment Framework (CAF) provides a systematic and comprehensive approach to assessing the extent to which cyber risks to essential functions are being managed by the organisation responsible. It is intended to be used either by the responsible organisation itself (self-assessment) or by an independent external entity, possibly a regulator or a suitably qualified organisation acting on behalf of a regulator.

Glossary

Electricity (power) generation
Electricity generated by the burning of gas.

Electrolysis
Electrolysis is the process of using electricity to split water into hydrogen and oxygen. This reaction takes place in a unit called an electrolyzer.

Emission legislation
Emissions legislation relates to The Industrial Emissions Directive (IED), which is the mandatory minimum emission standard that all European countries must comply with by 2023. The IED aims to prevent and reduce harmful industrial emissions, while promoting the use of techniques that reduce pollutant emissions and that are energy and resource efficient. The EU Withdrawal Act 2018 maintains established environmental principles and ensures that existing EU environmental law will continue to have effect in UK law, including the IED.

Entry terminals
These terminals allow gas supply to enter the NTS.

Exit points
Exit points are where gas exits the NTS e.g. to industrial users or to local infrastructure to provide gas to domestic homes.

Export
Gas demand on the NTS from interconnectors to continental Europe or the island of Ireland.

Flame chart
These charts are a visualisation of the range of potential flows into and out of the zones across the network and the physical capability we assess to be available.

Green Gas
Green gases are renewable and low carbon gases that can be used in place of fossil fuels, reducing carbon emissions in the heat, power, and transport sectors. They include biomethane, bio-propane, and hydrogen.

GWh
Gigawatt hours.

Heatmaps
As per flame charts with the addition of a 3rd dimension which is concentration of flows.

High resilience
Reflects levels of compressor capability which can be met 99% of the time.

Hybrid heating systems
The term refers to a system that uses a heat pump alongside another heat source. Typically, it describes fitting a heat pump alongside a fossil fuel (gas, oil or LPG) boiler.

Hydrogen
Hydrogen is a clean alternative to methane, also known as natural gas. It's the most abundant chemical element, estimated to contribute 75% of the mass of the universe. Here on earth, while it's present in nearly all molecules in living things, it's very scarce as a gas – less than one part per million by volume. Hydrogen can be produced from a variety of resources, such as natural gas, nuclear power, biogas and renewable power like solar and wind.

HyNTS Compression
HyNTS Compression investigates and demonstrates the opportunity of repurposing compressor systems for the compression of hydrogen and hydrogen blends in the National Transmission System (NTS).

HyNTS Deblending for Transport Applications
HyNTS Deblending for Transport Applications focuses on the delivery of high purity hydrogen from blended gas networks to enable delivery to transport applications, enabling hydrogen infrastructure to be provided more quickly and with greater resilience.

HyNTS Pipeline Dataset
HyNTS Pipeline Dataset looks to develop tools and processes to accelerate the pipeline assessment required for hydrogen readiness of NTS and Local Transmission System (LTS) pipelines.

HyNTS Protection
HyNTS Protection looks at protecting network assets from hydrogen permeation and maintaining asset lifetime using hydrogen barrier coatings, therefore reducing the cost of maintenance and replacement of network assets through the transition.

Glossary

Industrial Emissions Directive (IED)
The main EU instrument regulating pollutant emissions from industrial installations. The IED was adopted on 24 November 2010. The IED aims to achieve a high level of protection of human health and the environment taken as a whole by reducing harmful industrial emissions across the EU, in particular through better application of Best Available Techniques (BAT).

Interconnector
Two pipelines connecting GB and the EU. The Interconnector (UK) Limited is a bi-directional gas pipeline connecting Bacton in the UK and Zeebrugge in Belgium. BBL is a bi-directional gas pipeline connecting Bacton in the UK and Balgzand in the Netherlands .

Interconnector Limited
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ISO 14224 standard
ISO 14224 provides a comprehensive basis for the collection of reliability and maintenance (RM) data in a standard format for equipment in all facilities and operations within the petroleum, natural gas and petrochemical industries during the operational life cycle of equipment.

SO 55001 framework
ISO 55001 is an asset management system standard, the main objective of which is to help organizations manage the lifecycle of assets more effectively. By implementing ISO 55001 organizations will have better control over daily activities, achieve higher return with their assets, and reduce the total cost of risk.

LNG
Liquid Natural Gas that has been converted to liquid form for ease of storage or transport. It is formed by chilling gas to -161°C so that it occupies 600 times less space than in its gaseous form.

Margin
The difference between gas supply and demand. A positive margin indicates supply is greater than demand. A negative margin when demand is greater than supply.

Mcm
Million cubic metres.

Medium Combustion Plant Directive (MCPD)
The requirements for the MCPD are detailed in Pollution Prevention and Control (Scotland) (Amendment) Regulations 2017 that came into force 19 December 2017 and for England and Wales in the Environmental Permitting (England and Wales) (Amendment) Regulations 2018 that came into force 29 January 2018.

Methane
Methane (CH4) is a hydrocarbon that is a primary component of natural gas. Methane is also a greenhouse gas (GHG), so its presence in the atmosphere affects the earth's temperature and climate system. Methane is a short-lived climate pollutant with an atmospheric lifetime of around 12 years. While its lifetime in the atmosphere is much shorter than carbon dioxide (CO_2), it is much more efficient at trapping radiation. Per unit of mass, the impact of methane on climate change over 20 years is 86 times greater than CO_2; over a 100-year period it is 28 times greater.

Moffat interconnector
The interconnector pipeline that connects the British system at Moffat, in Scotland to the Republic of Ireland, Northern Ireland and the Isle of Man. Physical gas flows are currently only possible in the direction of exit from GB.

Storage
Gas storage facilities designed to switch rapidly between injection and withdrawal to maximise the value from changes in gas price.

N-1 test/conditions
The N-1 assessment means that we, as the Gas System Operator, have to ensure that:

- the NTS is designed and built to meet a 1-in-20 peak day demand as required under the Gas Transporters Licence. This is defined as the amount of infrastructure (pipes and compressors etc.) needed to transport the gas that would be required by our customers in the coldest day of winter, in the coldest winter we could expect in a 20 year period
- the high pressure gas network has sufficient redundancy to meet a 1-in-20 peak day demand, even with the failure of the single biggest piece of infrastructure.

National Cyber Security Centre (NCSC)
The National Cyber Security Centre (NCSC) is a government department that provides cyber security guidance and support helping to make the UK the safest place to live and work online.

Glossary

National Transmission System (NTS)
A high pressure gas transportation system consisting of compressor stations, pipelines, multijunction sites and offtakes. Pipelines transport gas from terminals to offtakes. The system is designed to operate at pressures up to 94 barg.

Network Asset Risk Metrics (NARMs)
Used by Ofgem, The Network Asset Risk Metric (NARM) has been developed to quantify the benefit to consumers of a company's asset management activities. In RIIO-2, this will be used as the output to hold the companies accountable for their investment decisions.

Network capability
This refers to the physical capability of the NTS i.e. how much gas can be transported throughout the system on a given day.

Network capability zone
The National Transmission System (NTS) is a complex system of physical assets such as pipes, compressors, valves, supply points and offtakes. In order to simplify this, the analysis of the NTS has been partitioned into zones that correspond to the way in which gas flows through it.

NTS shrinkage
NTS shrinkage is made up of 3 components. Unaccounted for gas (UAG) is unallocated gas or gas that is lost or stolen from the system. Own use gas (OUG), gas that is used in the running of the system e.g. compressor fuel. And calorific value shrinkage (CVS) where gas of a particularly low or high CV enters the distribution network which differs with the flow weighted average CV of gas entering that network.

Ofgem
Office of Gas and Electricity Markets – Great Britain's energy regulator.

Peak day capability
This refers to the maximum level of supply capability of the NTS.

Peak demand
This is a 1-in-20 demand which means that statistically, in a long series of winters, it would be exceeded in one out of 20 winters. The 1-in-20 peak day is calculated from a statistical distribution of simulated historical peaks days. It is not the highest demand in the last 20 years, nor is it the demand that would be expected in the cold weather experienced in the last 20 years.

Peak supply
This refers to the maximum supply that can be achieved on any given day.

Peaking plants
Peaking power plants, also known as peaker plants, and occasionally just "peakers", are power plants that generally run only when there is a high demand, known as peak demand, for electricity.

Physical Capability
The maximum amount of gas that the network can physically flow at specific locations without going outside any of its pressure obligations, or equipment's safe operational tolerances.

Planning and Advanced Reservation of Capacity Agreement (PARCA)
Developer and / or NTS Users (Shippers or Distribution Network Operators 'DNOs') can reserve firm NTS capacity through the Planning and Advanced Reservation of Capacity Agreement (PARCA) process. A PARCA is a bilateral contract that allows entry and/or exit capacity to be reserved for the customer while they develop their own projects.

Reliability, Availability, and Maintainability (RAM)
The RAM model is the output from a study undertaken to assess asset reliability, availability & maintainability.

Renewable
Forms of energy generation from renewable resources, which are naturally replenished, such as sunlight and wind.

Resilience
Resilience is the ability of the network to recover from unforeseen conditions such as asset failure. If, at a compressor site, there is a back-up unit, the site resilience is much higher.

RIIO-1
RIIO-1 relates to our business plan covering 2013-2021. Ofgem's performance-based RIIO model seeks to ensure consumers get the necessary investment in Britain's energy networks at a fair price. RIIO stands for Revenue=Incentives+Innovation+Outputs. Companies have to meet performance targets, set in consultation with consumers and network users: failure to do so brings automatic penalties.

Glossary

RIIO-2
The RIIO-2 period is 2021 to 2026. Ofgem's performance-based RIIO model seeks to ensure consumers get the necessary investment in Britain's energy networks at a fair price. RIIO stands for Revenue=Incentives+Innovation+ Outputs. Companies have to meet performance targets, set in consultation with consumers and network users: failure to do so brings automatic penalties.

Shale
Shale is a fine-grained, sedimentary rock formed as a result of the compaction of clay, silt, mud and organic matter over time and is usually considered equivalent to mudstone. Shale gas is natural gas found in shale deposits. This natural gas is a mixture of naturally occurring hydrocarbon gases produced from the decomposition of organic matter (plant and animal remains). Typically, shale gas consists of 70 to 90% methane (CH_4). This gas can be used for generating electricity and for domestic heating and cooking.

Single Value Framework (Copperleaf)
A tool to allow objective comparisons to be made around different types of investments, helping to highlight and quantify all the benefits of each investment in order to understand which offers best value, even if the investments are very different.

Steam Methane Reform (SMR)
Steam methane reforming (SMR) is a process in which methane from natural gas is heated, with steam, usually with a catalyst, to produce a mixture of carbon monoxide and hydrogen used in organic synthesis and as a fuel. In energy, SMR is the most widely used process for the generation of hydrogen.

The Network and Information Systems (NIS
The Network & Information Systems (NIS) Regulations, aimed at raising levels of cyber security and resilience of key systems across the EU, came into force in the UK in May 2018. The Department for Digital, Culture, Media & Sport (DCMS) is the UK government department responsible for NIS.

Thermal insulation
Thermal insulation is designed to improve temperature regulation through installation in walls, floors, ceilings, roofs and other spaces. Insulation can prevent too much heat loss in winter and too much heat gain in summer, therefore reducing the requirement for heating and/or air conditioning, therefore reducing energy demand.

UK Continental Shelf (UKCS)
UKCS is made up of the areas of the sea bed and subsoil beyond the territorial sea over which the UK exercises sovereign rights of exploration and exploitation of natural resources.

Uncertainty Mechanism (UM)
Uncertainty mechanisms (UMs) exist to allow price control arrangements to respond to change. They protect both end consumers and licencees from unforecastable risk or changes in circumstances.

Unit availability
The unit availability for the current year is based on actual historic performance, and the end of RIIO-2 values are based on the Reliability, Availability, and Maintainability (RAM) study findings and the planned investments during RIIO-2.

Weather corrected
The demand expected with the impact of weather removed. Actual demand is converted to demand at seasonally normal weather conditions, by multiplying the difference between actual CWV and expected CWV by a value that represents demand sensitivity to weather.

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