Project Union
St. Fergus to Teesside

Net Zero Pre-construction Work and Small Net Zero Projects Re-opener Submission

August 2024

Issue: 1.0

Version: Final

Key Contacts

Please direct any questions or comments regarding this submission to

Danielle Stewart
Project Director – Project Union
danielle.stewart@nationalgas.com

Tony Nixon
Regulation Director, Gas Transmission
tony.nixon@nationalgas.com

Version control

Version/revision number	Date of issue	Authors	Notes
V1.0	23/08/24	Sare Allen Lydia Vaughan Ana Bazan Cueva	Final Version

Reviewers

Name	Role Title	Review Date
Emily Ly	Hydrogen Strategy Manager	29/08/24
Mark McKenzie	Hydrogen Development Manager	29/08/24
Francis Dike	Future Regulatory Framework Manager	29/08/24

Management approval

Name	Role Title	Review Date
Danielle Stewart	Project Director – Project Union	29/08/24
Tony Nixon	Regulation Director	29/08/24
Ian Radley	System Operator Director	29/08/24
Nick Hooper	Chief Financial Officer	29/08/24

This document has been produced pursuant to Special Condition 3.9 of National Gas's Gas Transporter Licence ('the Licence') which relates to the Net Zero Pre-construction Work and Small Net Zero Projects Re-opener ('NZASP') mechanism and produced in accordance with Special Condition 9.4 Re-opener Guidance and Application Requirements Document.

Contents

1. Executive Summary

Project Union is a pioneering project led by National Gas Transmission (NGT), which will create a hydrogen transmission backbone for the UK, facilitating the transport of 100% hydrogen, Figure 1. By the mid-2030s, the backbone will connect strategic hydrogen production sites, industrial clusters, and hydrogen storage facilities, while serving major industrial customers and power generation sites directly, as well as through Gas Distribution Network (GDN) connections. This initial hydrogen transmission network then has the opportunity to expand to connect additional consumers, ensuring hydrogen is a central driver to a net zero future.

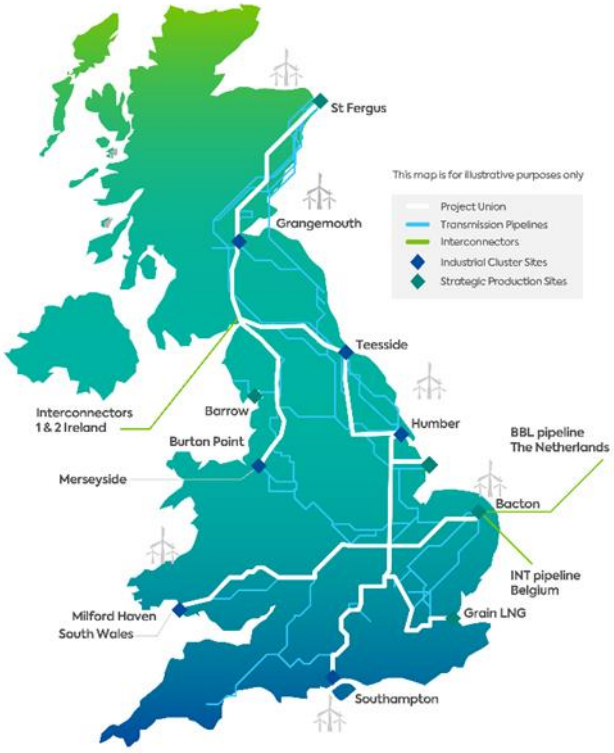


Figure 1 - Project Union map (illustrative).

There is a clear need to act now, and at pace, to realise crucial UK Government decarbonisation targets, while ensuring we service customer requirements. Across the net zero compliant scenarios, integrating hydrogen into the economy is identified as a crucial strategy in order to meet the UK Government's legally binding target of net zero by 2050. A hydrogen transmission network, delivered by Project Union, will allow a secure and resilient hydrogen economy to grow. Key recommendations support this, including the National Infrastructure Commission's (NIC) second National Infrastructure Assessment[1] which details the recommendation to create a core hydrogen transmission network by 2035, with the Climate Change Committee (CCC) outlining the need for a hydrogen network if hydrogen is to be used outside of planned clusters[2].

To enable these targets to be met, Project Union will deliver a UK hydrogen transmission backbone in stages across geographical regions. This requires linking regions with strategic production capabilities, storage capacity, and concentrated demand. The St. Fergus to Teesside region has a

[1] Second National Infrastructure Assessment - NIC
[2] Delivering a reliable decarbonised power system - Climate Change Committee (theccc.org.uk)

large potential for hydrogen production due to its onshore and offshore wind power. It also holds a location of concentrated industrial sites in Grangemouth and includes the link to the Ireland interconnectors. The positive balance of its production and demand capabilities offers a hydrogen surplus available for distribution to the rest of UK and exports to Europe. Development of this region's hydrogen economy will boost the UK's decarbonisation, resilience, energy security, and green economic growth. Project Union: St Fergus to Teesside (PU: St. Fergus to Teesside) will develop a transmission network within this region, transporting 100% hydrogen, and connecting to the wider Project Union network to deliver a UK wide hydrogen backbone.

In developing options for both the full Project Union backbone and PU: St. Fergus to Teesside specifically, the repurposing of existing National Transmission System (NTS) pipelines for hydrogen has been considered due to the significant environmental, cost and time benefits that this approach provides. The recommended option for PU: St. Fergus to Teesside is a hybrid solution consisting of both repurposed NTS pipelines and new build pipelines. To mitigate against the risk that repurposing may not be technically feasible or there is an alternative use for that pipeline, a full new build option has also been developed and both solutions will initially be carried forward into FEED. Until such time the evidence either promotes repurposing or otherwise, at which point we will cease FEED work on the discounted option. This approach prevents any delays of delivery of a core hydrogen transmission network to support the realisation of Government decarbonisation targets.

National Gas Transmission seeks to enable the Net Zero transmission in the most efficient manner through repurposing of existing assets to Hydrogen and Carbon transportation. In Scotland, we have identified [redacted] as a candidate for repurposing that has the potential to support either Hydrogen or Carbon transportation, while maintaining a resilient and capable natural gas system.

We are working to understand the benefits that [redacted] would offer to both options. Once we have fully developed the evidence base for both, we will engage with DESNZ, Ofgem and NESO to seek agreement on which would be preferred. Until that time, in order to avoid prematurely closing off options, we will continue to consider the repurposing of [redacted] in both Carbon and Hydrogen projects. To maintain flexibility, consideration will also be given to continuing the development of alternative options as and where the individual projects allow.

Final repurposing outcome is subject to completed FEED study and Asset Disposal policy requiring Secretary of State Approval.

The purpose of this document is to provide robust evidence for the requirement of additional regulatory funding during the RIIO-2 price control period under the Net Zero Pre-construction Work and Small Net Zero Projects Re-opener (NZASP) Re-opener mechanism for the value of £98.497m (18/19 price base) for the next phase of Project Union.

This proposed phase of work will deliver the following outcomes over a 24-month period:

- **St. Fergus to Teesside FEED** – Will narrow down routing options for the proposed section from preferred options identified during pre-FEED, as well as deliver conceptual design, land and consents, and supply chain activities.

PU: St. Fergus to Teesside FEED specific activities will provide the technical evidence for pipeline routing options. However, for a hydrogen transmission network to be operational, a wider suite of activities must be carried out. This includes ensuring relevant systems are adapted, commercial frameworks are in place and customer and stakeholder needs are understood. The Project Union: Essential Enabling Activities, requested through the PU: East Coast Re-opener, will be carried out in parallel and will support PU: St. Fergus to Teesside FEED. These activities are not funded through this submission.

Processes and scope requirements which exceed the 24-month period proposed through this submission have been excluded and funding will be sought at a later date once further information is available. For example, as the Feasibility phase has not selected a preferred option, the scope of works and cost for the full DCO submission has not been included.

PU: St. Fergus to Teesside will demonstrate the case for a cost-effective hydrogen transmission network for this region focussing on delivery from both a physical and commercial perspective, whilst maintaining a resilient continuity of supply on the methane network. It will also develop technical, economic, societal, regulatory, environmental, and logistical evidence at a granular level to inform policy decisions for further phases.

Proposed increases to RIIO-2 NZASP allowances are presented in Table 1. Justification for the scope and level of this increase is made throughout this document, broadly grouped into policy justification, establishing the needs case, value for money and regulatory treatment and impact.

Price Base	2021/22	2022/23	2023/24	2024/25	2025/26	2026/27	Total
[redacted]							
2018/19	[redacted]						98.497

Table 1 - Proposed increase to RIIO-2 NZASP allowances. Figures shown in £m and inclusive of contingency.

In accordance with the relevant terms of the Licence, this application is made at the invitation of Ofgem following an 8-month period of pre-application engagement, and the agreement of a needs case in principle. As required by the Licence, this document is produced in compliance with the relevant governance and guidance documents as published by Ofgem[3,4].

[redacted]

[3] Re-opener Guidance and Application Requirements Document: Version 3 | Ofgem
[4] Net Zero Pre-construction and Small Projects Re-opener Guidance (ofgem.gov.uk)

2. Document Structure

This document comprises 11 core chapters, supported by additional appendices, designed to provide clear explanation and justification for the proposed scope and funding request to deliver Front-End Engineering Design (FEED) for PU: St. Fergus to Teesside.

- Project Description: This chapter outlines the wider project and work carried out to date as well as PU: St. Fergus to Teesside and the proposed scope of works for this submission. This chapter also summarises the projects alignment with NGT overall business strategy and commitments.

- Strategic Fit and Alignment with Policy Objectives: This chapter outlines the relevant policy publications and objectives as well as our understanding of the future landscape. Key documents are expanded and the strategic fit of Project Union with the various policy aims is described.

- Needs Case: This chapter sets out the need for Project Union: St. Fergus to Teesside, detailing the demand, production and storage requirements and opportunities available and how Project Union will provide economic, environmental, and societal benefits in the region as well as nationally. This chapter also provides an overview of externally supported evidence through independent benefit assessments.

- Stakeholder Engagement and Whole System Opportunities: This chapter describes the insights gained through outreach activities to our customers and stakeholders in support of Project Union. This includes forecasting as well as suitability and compatibility, as well as alignment across whole system opportunities. Case studies are detailed alongside a future facing engagement plan to continue these activities.

- Options: This chapter outlines the assessment undertaken to determine a preferred list of options for routing across the St. Fergus to Teesside region. Methodology, assessment criteria, scoring and results are described in further detail with support from supplementary documents.

- Scope of Works: This chapter provides detail on the key outcomes, success criteria and deliverables anticipated for this Phase of work, and how these maps to key evidence points to support Government decision making on the long-term role of a hydrogen backbone.

- Cost Information: This chapter outlines the approach taken to develop the scope and costs being proposed for funding for this Phase of work. We describe the methodology adopted for the treatment of real price effects and general inflation aligned to RIIO-2 framework principles, and how risk and contingency has been reflected in our cost plan. We demonstrate how minimum cost has been assured to support value for money for gas network users and consumers.

- Project Delivery and Monitoring: This chapter describes the proposed project delivery plan for this Phase of work and provides an explanation of our internal project structure and governance framework.
- Regulatory Treatment and Impact: This chapter provides a statement of the funding principles adopted when considering the appropriate regulatory treatment for the project, based on feedback provided by Ofgem. The chapter confirms the eligibility of this project for funding under the NZASP Re-opener and proposes the specific regulatory treatment that could be adopted under this mechanism.
- Adopting a Proportionate Approach to Evidence: This chapter describes the key factors, evidence and considerations that have shaped the content and scope of this submission.
- Assurance: This chapter outlines the key activities and approach taken to ensure this submission meets all regulatory requirements around data handling and assurance.
- Appendices: This chapter provides additional information provided in support of this submission and referenced through the document where relevant.

3. Project Description

Project Union will deliver a hydrogen transmission backbone for the UK through a phased delivery across regional areas of the UK. Figure 2 shows an illustrative view of this backbone. The backbone will initially link strategic hydrogen production sites, including the industrial clusters, with storage and users across the UK by the mid-2030s and provide the option to expand beyond this initial hydrogen transmission network to connect additional consumers. This re-opener focuses on the next phase of delivery PU: St Fergus to Teesside, with subsequent submissions focusing on the other regions. Through a combination of repurposed existing assets, and new infrastructure a hydrogen backbone of up to 2,500km will be created. A hydrogen backbone will be at the heart of a net zero future, acting as a key enabler for developing a hydrogen economy and realising key UK Government targets.

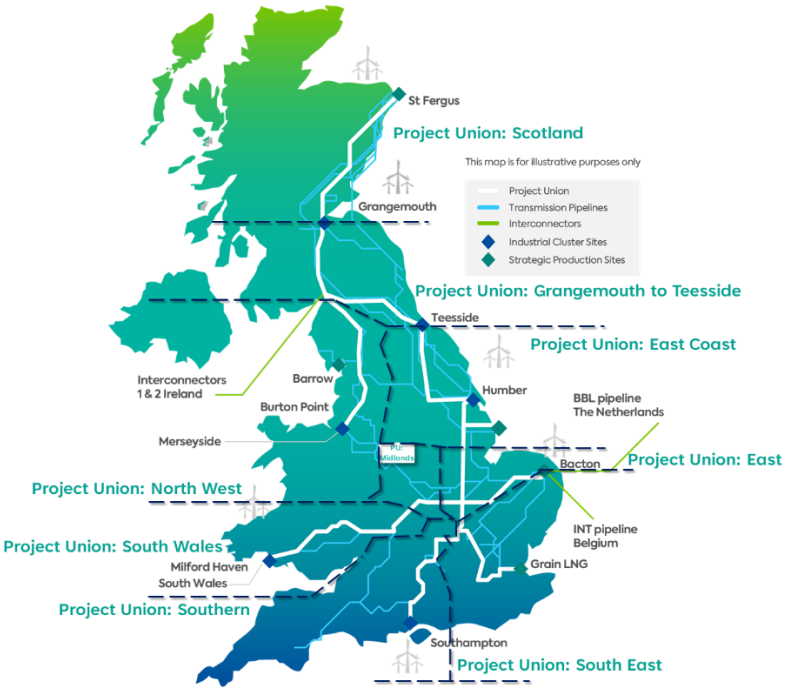


Figure 2 - Project Union Map (Illustrative) This map illustrates the breakdown of sections used to inform the technical options assessment; sections included in funding submissions may be a combination of these sections

The overall Project Union programme will adopt a phased approach to delivery, across the geographical regions outlined above. This approach has been taken to ensure that the delivery of a hydrogen backbone accounts for network resilience, while taking into consideration key requirements such as future policy decisions and alignment with user need signals. A phased approach further provides optionality in the size and scale of a hydrogen transmission network that can be delivered over time, ensuring minimised risk for consumers and efficient delivery. Building on the outcomes of the Feasibility phase, we have developed a proposed scope and funding requirement to deliver FEED for PU: St. Fergus to Teesside. This covers two sections of the backbone shown in Figure 2, PU: Scotland and PU: Grangemouth to Teesside. We highlight the reasons for this in the needs case chapter. This submission is in parallel to our Project Union: North West submission

and follows our NZASP Re-opener submission for Project Union: East Coast, ultimately connecting and creating a hydrogen network in Scotland and the North of England.

PU: St. Fergus to Teesside

This submission involves connecting St. Fergus to Grangemouth industrial cluster, continuing south to Teesside industrial cluster. This section will play a pivotal role in connecting the large potential of low carbon hydrogen production from Scotland's large renewable energy (north of Scotland) to industrial demand centres down south, enabling the decarbonisation of several of the largest emitters in Scotland (Grangemouth cluster) and connectivity to large storage centres in other regions along the backbone. It is estimated that the hydrogen produced in Scotland by 2045 could reach 126 TWh, with 94 TWh exported beyond Scotland[5], PU: St. Fergus to Teesside will unlock these exports opportunities to Ireland (Moffat interconnector), EU and the UK.

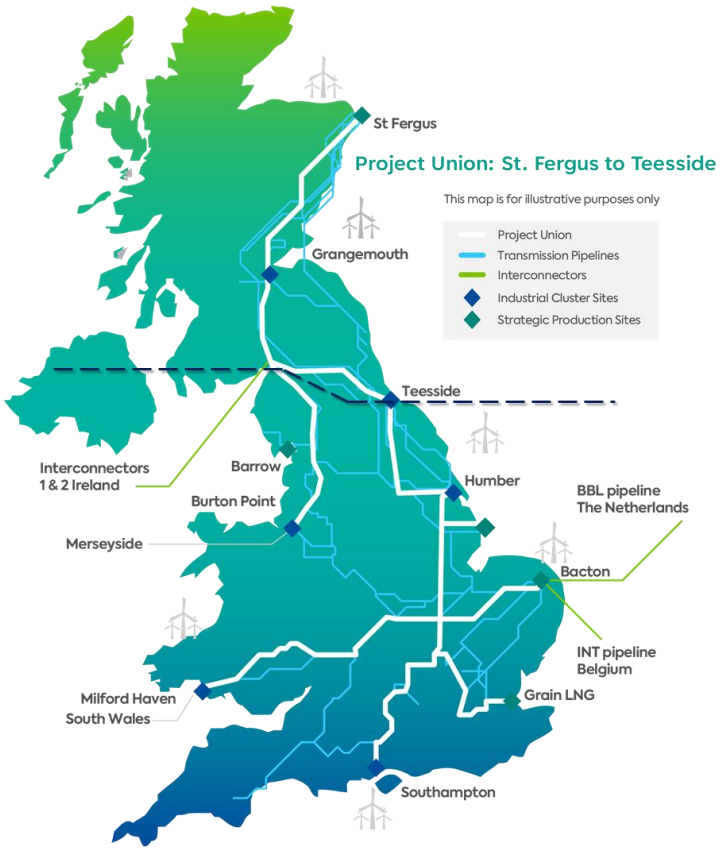


Figure 3 - PU St. Fergus to Teesside boundary

Figure 3, shows the boundary of St. Fergus to Teesside section, the region in which this submission's FEED focuses on. By developing a hydrogen transmission network in the St. Fergus to Teesside region, NGT will be able to connect the surplus production from Scotland to other regions of Project Union, realising wider system benefits and allowing a continuation in design and development of a national hydrogen transmission network. Chapter 5 highlights the needs case for this section and justification on the phasing of the St. Fergus to Teesside region.

[5] Ministerial Foreword - Hydrogen action plan - gov.scot (www.gov.scot)

This project phase will demonstrate the case for a cost-effective hydrogen transmission network for the St. Fergus to Teesside region focusing on delivery from both a physical and commercial perspective whilst maintaining a resilient continuity of supply on the methane network. This phase will deliver a FEED study, developing a single preferred design option for this section of Project Union which will be taken through to the construction phase. This phase of work will also develop technical, economic, societal, regulatory, environmental, and logistical evidence to inform policy decisions for further phases. The total cost to deliver this phase will be £98.497m[6] (18/19 prices base) over a 24-month period.

Changes in supply and demand patterns and levels during the lifetime of the NTS have provided the opportunity for some assets to be removed from the NTS with an acceptable impact on natural gas customers and/or a limited amount of reinforcement. Repurposing existing infrastructure will have a lower environmental impact than new build, for example through reduced demand for raw materials and therefore lower greenhouse gas emissions, and through reduced disruption and environmental impact through a smaller amount of construction activity. Studies have shown that repurposing will also be highly beneficial from a cost and time viewpoint. There are clear benefits associated to repurposing existing infrastructure however a wider socio-economic assessment will always be conducted to determine the most appropriate solution for each region of the Project Union backbone to ensure the most beneficial solution is proposed.

In order to deliver Project Union on a timeline that supports the delivery of Government decarbonisation targets, it is necessary to progress the early stages of project development in parallel to completing validation of the evidence base for some of the technical considerations around repurposing. The benefits of the repurposing approach are so significant that this approach is considered appropriate however, there is still a risk that repurposing may ultimately not be possible for technical reasons.

This may be due to, for example:

- The inability to release pipelines from the NTS (e.g., the results of more comprehensive network analysis identify an unacceptable impact on NTS operability or risk levels)
- More detailed condition assessment identifies technical defects that preclude repurposing for Hydrogen use
- Other findings from ongoing innovation projects preclude repurposing NTS pipelines and wider assets for Hydrogen use
- In addition to technical reasons that preclude repurposing there may be commercial or wider strategic reasons that align with UK Government policy to look at alternative options. For example, alternative uses of the assets such as for CCUS which indicate greater socio-economic benefits

Every effort has been made during and prior to the feasibility phase of Project Union to identify and assess the primary factors which may lead to an adverse repurposing decision. Based on the work conducted to date there is a high level of confidence that repurposing is technically possible. However, there remains a risk that new information may come to light.

[6] 2018/19 Price – base year for RIIO-2 price control period

The likelihood of technical risks materialising is considered to be very low, but the consequences of these risks materialising could be significant. The most notable consequence would be a major impact on the project timeline and thus the ability to facilitate decarbonisation objectives in the St Fergus to Teesside region by the current target dates. To mitigate this risk, a full new build option has also been developed as part of the pre-FEED. This option would achieve the same objectives of connecting customers to a core Hydrogen backbone, but by constructing an entirely new pipeline network.

Figure 4 shows a high-level delivery plan for PU: St. Fergus to Teesside FEED over a 24-month period[7]. Subsequent PU: St. Fergus to Teesside specific phases as well as Project Union Essential Enabling Activities (funded through PU: East Coast Re-opener subject to funding decision) will be delivered in parallel. It also demonstrates the alignment with policy targets.

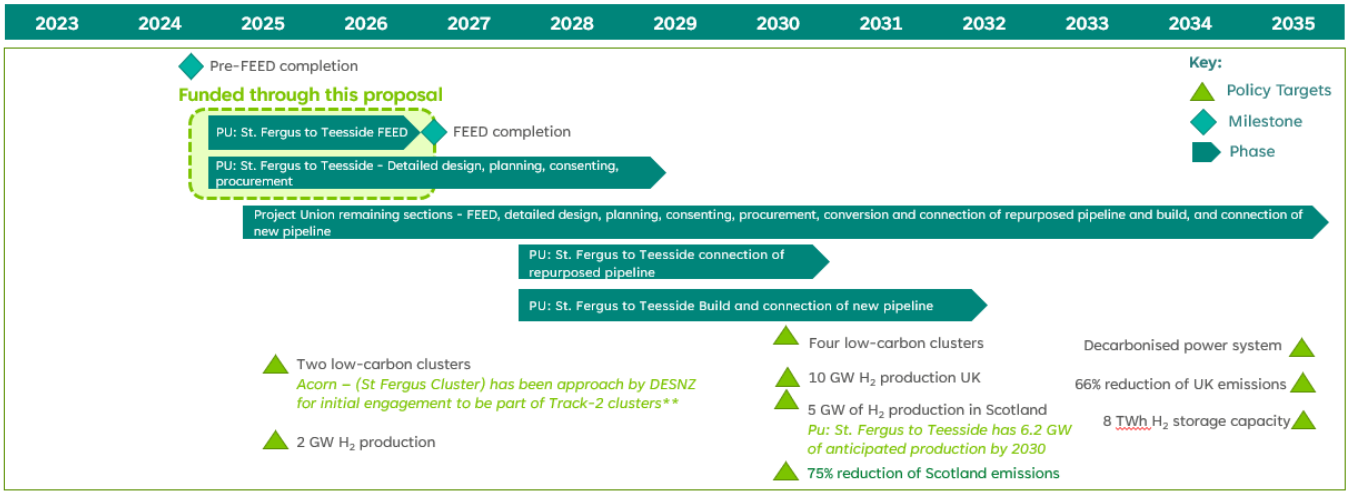


Figure 4 - PU St. Fergus to Teesside Delivery Plan

In accordance with the relevant terms of the Licence, this application is made at the invitation of Ofgem following an 8-month period of pre-application engagement, and the agreement of a needs case in principle. As required by the Licence, this document is produced in compliance with the relevant governance and guidance documents as published by Ofgem[8,9]. [redacted]

3.1 Alignment with overall Business Strategy and Commitments

A key element of NGT's strategic priorities is "shaping the energy market of the future". NGT sits at the heart of the gas market being the sole owner and operator of the UK gas NTS, with a strong purpose of "Leading a Clean Energy Future for Everyone". We will need to continue to ensure that

[7] The work for this reopener was carried out ahead of the new Labour Government and the latest ambition for a decarbonised power system by 2030. This more stretching target increases the need for decision making and action as soon as possible.

[8] Re-opener Guidance and Application Requirements Document: Version 3 | Ofgem

[9] Net Zero Pre-construction and Small Projects Re-opener Guidance (ofgem.gov.uk)

we operate a secure, resilient network, making the necessary investments on the remaining gas network to enable the transition to the hydrogen network of the future. Figure 5 outlines our purpose, values, and priorities.

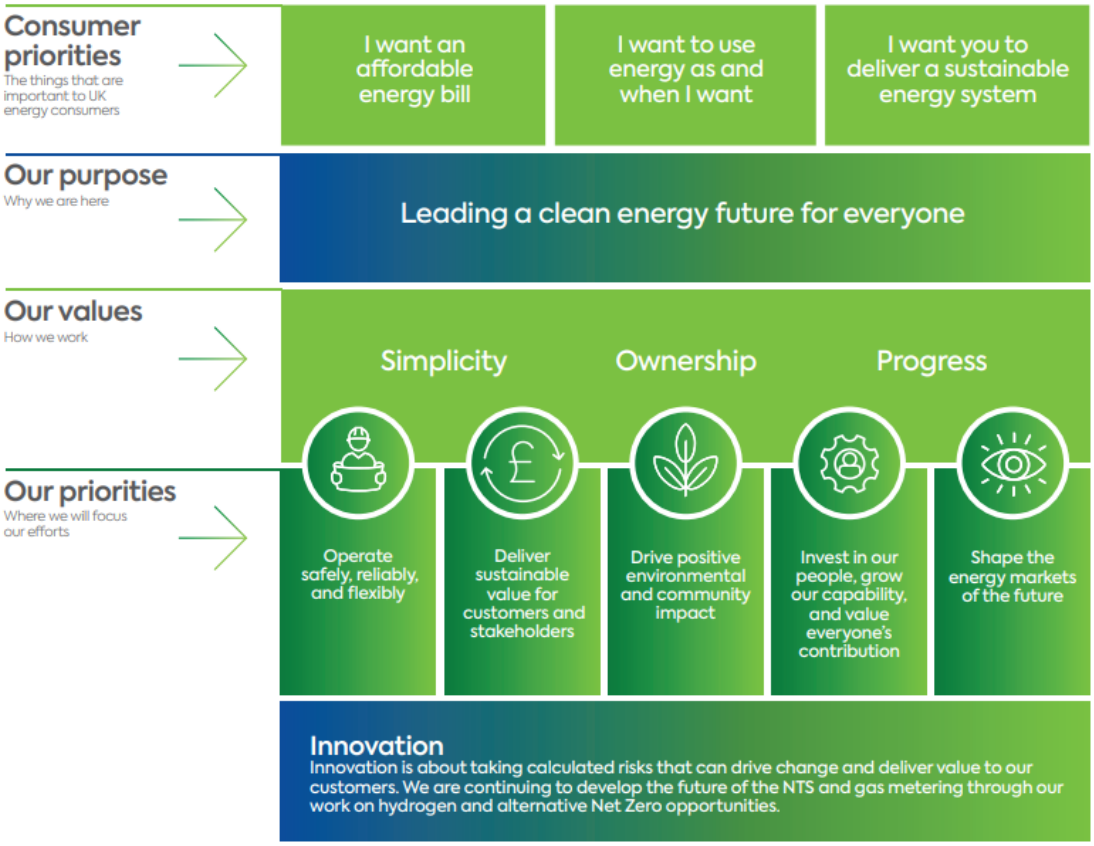


Figure 5 - Our purpose, values, and priorities

When we built our RIIO-2 business plan, our stakeholders told us they wanted us to deliver an environmentally sustainable network by:

- Caring for the environment and communities
- Maintaining a safe and resilient network
- Facilitating the whole energy system of the future - innovating to meet the challenges ahead

We committed to:

- Be ready to start conversion to hydrogen by 2026
- Facilitate the use of green gas
- Provide resilience to renewable generation
- Deliver the transition as a responsible business

These commitments are supported by Uncertainty Mechanisms set out by the business and regulator. Special Condition 3.9 of the Licence, NZASP Re-opener, provides a mechanism for us to deliver on those commitments. Chapter 11 Regulatory Treatment and Impact sets out why the NZASP Re-opener is the appropriate mechanism to fund this work.

Project Union aligns to these business commitments through:

- Delivering a UK hydrogen backbone that will link gas distribution networks, power generators and large industrial gas users to production and storage of low carbon hydrogen, creating a resilient and dynamic low carbon hydrogen system.
- Minimising disruption and cost of the transition to hydrogen by maximising the repurposing of existing assets and minimising the amount of new build infrastructure
- Providing the option for connection of users outside of the industrial clusters as the network expands
- Supporting a whole UK energy system approach to decarbonisation by:
    - Providing critical resilience and flexibility to the electricity system during periods of low renewable electricity generation
    - Reducing whole system costs by enabling the full utilisation of renewable generation through the provision of energy storage
    - Enabling options for future whole system infrastructure investment to be taken forward in an optimal way across vectors

The FEED phases of Project Union will focus on a more detailed engineering analysis to allow the phased conversion of the NTS for hydrogen integration. This will bring the project to a funding decision point that could allow conversion of the network from 2026.

It is critical that the details surrounding the next price control period are continually assessed to ensure the timelines surrounding NGT's business strategy and commitments align to the project submission. Our aim is for this phase of outputs to inform required updates to our business plan to ensure that informed decisions regarding the integration of hydrogen into the NTS are incorporated, reflecting the most recent information.

4. Strategic Fit and Alignment with Policy Objectives

4.1 UK Policy

Since Net Zero Greenhouse Gas Emissions by 2050 was set into UK legislation in June 2019 the decarbonisation policy landscape has continued to evolve, Figure 6. In parallel, Scotland have legislated Net Zero by 2045 in September 2019, five years ahead of the UK, Figure 7. The UK and Scottish Governments have continued in their support and ambition to develop a thriving and global leading low-carbon hydrogen economy and the policy landscape outlines the requirements for developing supporting national infrastructure.

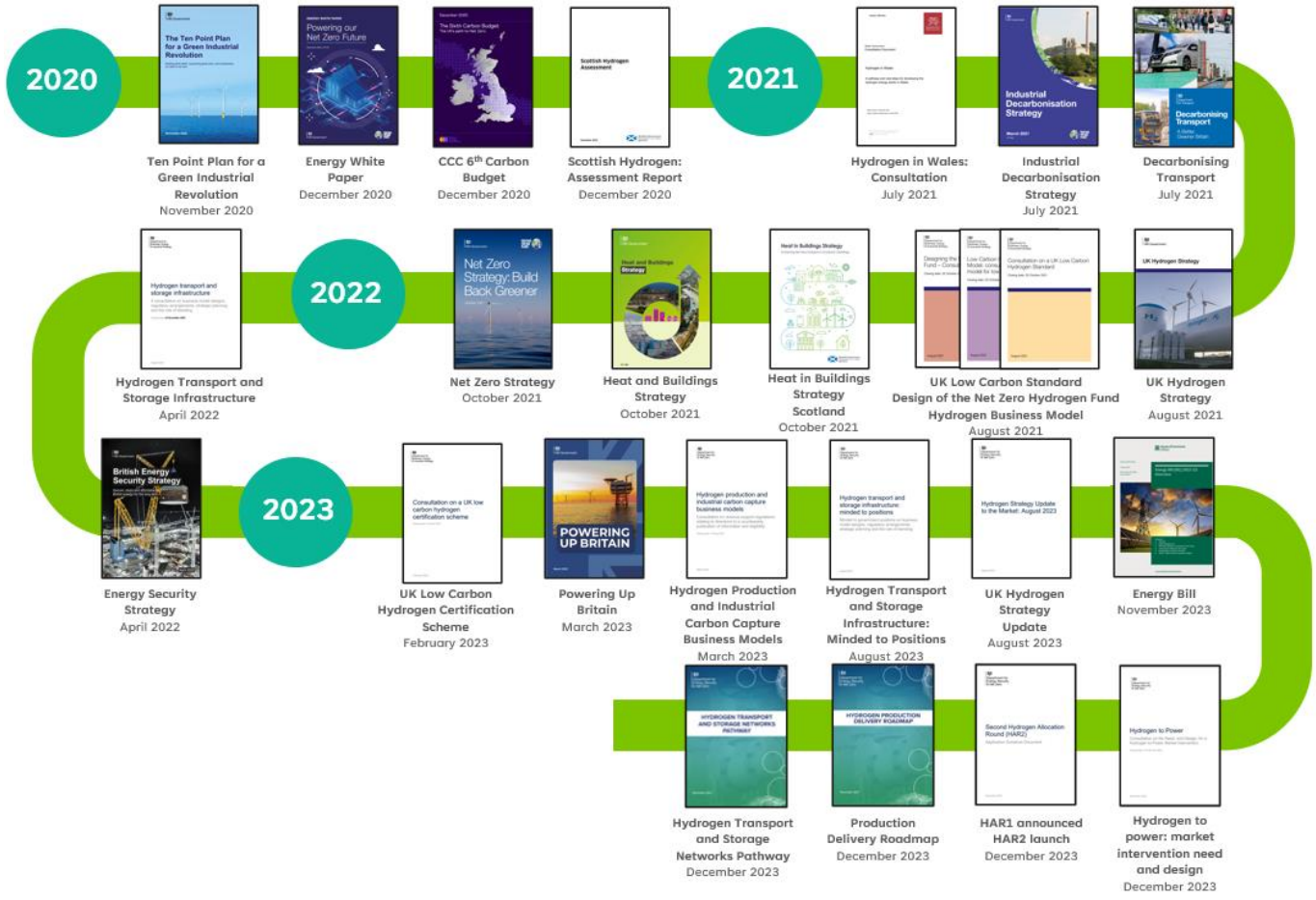


Figure 6 - UK decarbonisation policy landscape

Several UK Government policies highlight targets and ambitions relating to hydrogen:

- Hydrogen Transport and Storage Business Model due in 2025[10]
- 10GW Hydrogen production capacity by 2030 (UK)[11]
- Distribution level blending expected at the earliest 2025-26
- Net zero power system by 2035[12] (This is now clean power by 2030 under the current Government)

[10] British energy security strategy - GOV.UK (www.gov.uk)
[11] Hydrogen Net Zero Investment Roadmap (publishing.service.gov.uk)
[12] Plans unveiled to decarbonise UK power system by 2035 - GOV.UK (www.gov.uk)

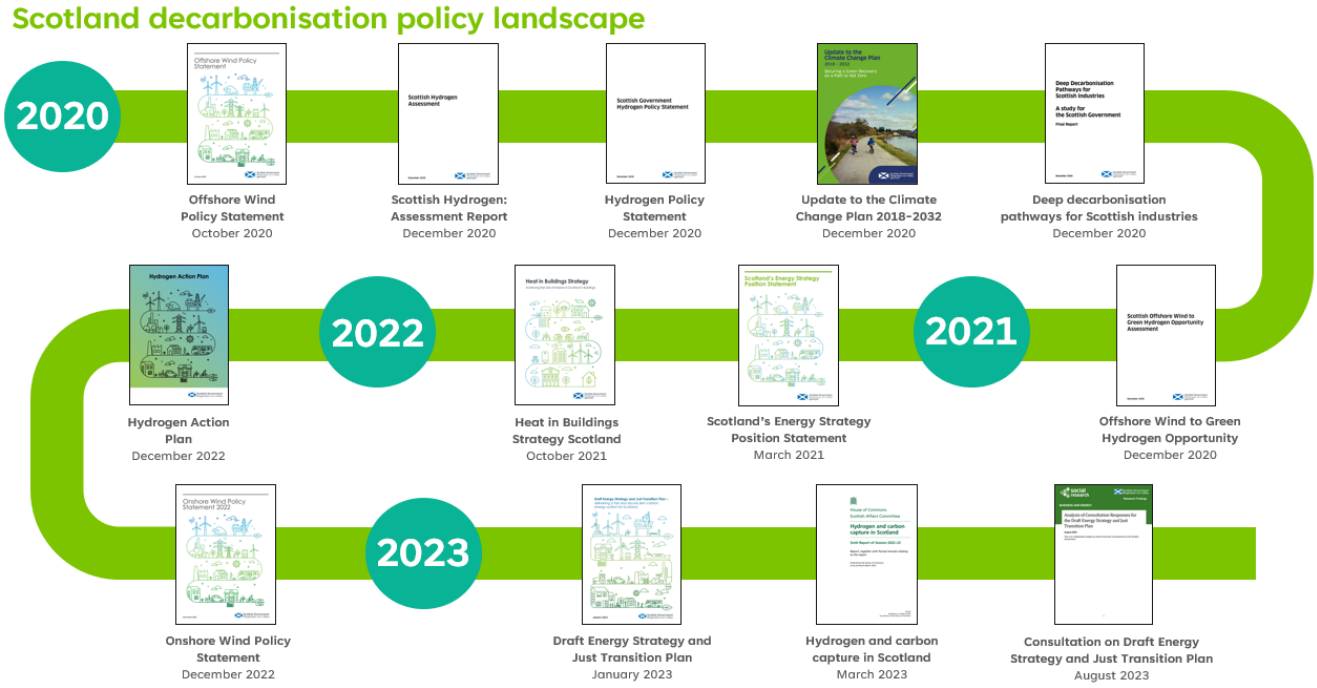


Figure 7 - Scotland decarbonisation policy landscape

Targets and ambitions relating to hydrogen in Scotland:

- 5GW Hydrogen production capacity by 2030 and 25GW by 2045
- Deliver minimum renewable electricity installed capacity of 20 GW of onshore [13] and 8 -11 GW of offshore wind capacity by 2030[14] which will allow the integration of hydrogen to Scottish energy system[15]

These policy targets provide a roadmap for network hydrogen integration, by signalling a commitment to reduce greenhouse gas emissions, through the adoption of low-carbon hydrogen. As the UK and Scotland governments promote private sector investment, accompanied by available public funding, we can expect advancements in hydrogen production and storage solutions alongside expanded hydrogen transportation. Project Union will be a key enabler in achieving these targets, by providing the connection between production, demand, and storage sites allowing the UK to release the full potential of the hydrogen value chain, with the potential for hydrogen import and export opportunities.

DESNZ have been actively involved in supporting the adoption of hydrogen, with security of supply being highlighted as a key priority. The recently published Transport and Storage Networks Pathway[16] defines the benefits of a core hydrogen transport network, mentioning the need to connect the north of Scotland with demand centres further south to unlock huge potential for offshore hydrogen production. This publication also highlights that pipeline infrastructure would enable the development of the four Carbon Capture Utilisation and Storage (CCUS) clusters, citing

[13] Supporting documents - Onshore wind: policy statement 2022 - gov.scot (www.gov.scot)
[14] Offshore wind policy statement - gov.scot (www.gov.scot)
[15] Hydrogen Action Plan (www.gov.scot)
[16] Hydrogen transport and storage networks pathway - GOV.UK (www.gov.uk)

the Acorn projects' cluster. Project Union aligns with the strategic priority to enable decarbonisation of industry and power, delivered through a core network expansion approach. PU: St. Fergus to Teesside will contribute to building the emerging regional hydrogen networks through connecting production and demand to suitable storage at scale, in adjacent Project Union sections, by the early 2030s, providing the opportunity to scale up beyond the region as the hydrogen economy continues to grow. Further to this, the Production delivery roadmap has provided a clear timeline and vision for hydrogen production to 2035, which supports the continued ambition for 10GW of hydrogen production by 2030.

Additionally, publications aiming to support shaping the decarbonisation policy landscape like the National Infrastructure Commission's (NIC) second National Infrastructure Assessment[17] sets the significant recommendation that Government should commit to the development of a core hydrogen pipeline network, setting out a vision for the initial core network by the end of 2024 and that such pipeline should be operating no later than 2035. This report highlights that a core hydrogen transmission network should connect Grangemouth, North East Scotland, Teesside, among other industrial centres in the UK. This is supported by a series of recommendations for Government in support of levelling up the hydrogen economy, outlining the criticality that Government establishes effective business models that incentivise investment in large scale hydrogen.

4.2 EU Policy

European hydrogen policy continues to evolve with focus placed on supporting commercial scale projects for low-emission hydrogen production and infrastructure, for example the EU Important Projects of Common European Interest[18]. Europe's targets include the development of renewable hydrogen aiming to produce 10 million tonnes and import 10 million tonnes by 2030[19]. With hydrogen playing this critical role in supporting European-wide government climate commitments, PU: St. Fergus to Teesside provides the opportunity to connect Scotland's production surplus capabilities through Project Union network to a wider European Hydrogen Backbone and enable continued cross border trade and access to emerging European and Global hydrogen markets.

The International Hydrogen Progress Index reported that the UK must respond to other countries making bold and ambitious interventions or run the risk of falling behind in the global race for hydrogen investment[20]. The report details the UK's ability to develop efficient transport infrastructure for hydrogen from production to storage sites and connect to the European hydrogen network. However, several European countries have surpassed the UK's hydrogen developments, for example, Germany is now set to deliver €7 billion in government investments targeted at developing green hydrogen[21]. In addition, the European Commission has approved a €3 billion

[17] Second National Infrastructure Assessment - NIC
[18] Global Hydrogen Review 2022 – Analysis - IEA
[19] Hydrogen - European Commission (europa.eu)
[20] International Hydrogen Progress Index – Energy Networks Association (ENA)
[21] UK slips down the International Hydrogen Progress Index – Energy Networks Association (ENA)

scheme to support the construction of the hydrogen core network[22]. The UK needs to move faster and become more flexible with production support; identifying and supporting strategic infrastructure investment, incentivising the use of hydrogen across all sectors, and maximising economic opportunity, or face the risk of falling behind.

4.3 Future Government Policy Horizon

The hydrogen policy landscape will continue to evolve in response to a growing economic, technical, and social evidence base. Future policy will be pivotal in the development and advancement of the UK hydrogen economy.

Within the British Energy Security Strategy[23], the Government committed to designing a dedicated business model, to support the build-out of transport and storage infrastructure across the UK energy system. DESNZ have proposed an accelerated timeline, within the market engagement on the hydrogen transport and storage business models, for the business model allocation process to be run in advance, Q3 2024, of the business model being operationalised, 2025. Project Union is instrumental in establishing the required infrastructure for hydrogen transport, through connecting all aspects of the hydrogen value chain and integrating the hydrogen transport system, hence, should be recognised as a key strategic project in the identification of a pathway for the early build-out of hydrogen transport and storage infrastructure.

UK Government introduced the Energy Bill[24] to help unlock private hydrogen investment and growth, while alleviating concern surrounding investment decisions in the UK market. The bill will enable government to implement and administer hydrogen business models, including the allocation of a regulated asset base (RAB)-style regulatory model for hydrogen transport. This will encourage hydrogen uptake as investors can obtain the certainty required to progress at pace, ensuring that government targets for hydrogen storage can be met. Project Union will therefore be a key enabler in ensuring that multiple producers and consumers can receive the connectivity required to meet government targets and achieve net zero.

The Industrial Decarbonisation Strategy[25] explores how extensive national infrastructure networks for CCUS and hydrogen can lower overall residual emissions from UK industry by reaching dispersed sites that cannot fully electrify. The Government's Ten Point Plan for a Green Industrial Revolution[26] committed to establishing two low carbon industrial clusters by the mid-2020s and four sites by 2030. PU: St. Fergus to Teesside will provide the industrial cluster connection between the Acorn CCUS project, under initial engagement with DESNZ to be included in CCUS Track-2[27], and the other CCUS clusters in the North West and East Coast. This link will provide a low-carbon alternative to these carbon emitting sites and ensure security of supply through connecting clusters is a priority.

[22] Commission approves German State aid scheme (europa.eu)
[23] British energy security strategy - GOV.UK (www.gov.uk)
[24] Energy Bill [HL] - Parliamentary Bills - UK Parliament
[25] Industrial decarbonisation strategy - GOV.UK (www.gov.uk)
[26] The ten point plan for a Green Industrial Revolution - GOV.UK (www.gov.uk)
[27] CCUS Cluster Sequencing Track-2: Market update December 2023 - GOV.UK (www.gov.uk)

PU: St. Fergus to Teesside supports the development of a combined energy system approach between low-carbon hydrogen and electricity by providing a route for surplus hydrogen production to storage, with key stakeholders outlining the diversity of industry within the region, and a combination of technologies needed to decarbonise.

Further work is being progressed to better understand the role in which hydrogen can play in home heating. As explored by DESNZ, within the strategic policy decision - Hydrogen Blending into GB Gas Distribution Networks, HyDeploy industry trials, demonstrations and tests are being completed to gather evidence to demonstrate whether blending can be used safely in the GB gas distribution networks. In Scotland, SGN's H100 Fife project aiming to power a village with green hydrogen is expected to go live in summer of 2025 and be operational for 2 years[28]. The is evidence base built on hydrogen home heat will be used by the government in the UK Hydrogen Strategy and British Energy Security Strategy.[29] However, it should be noted that the requirement for an integrated UK hydrogen backbone, is not contingent on the positive hydrogen in heating decision.

[28] H100 Fife | Future of Gas | SGN
[29] Hydrogen heating: overview - GOV.UK (www.gov.uk)

5. Needs Case

We have developed a robust, viable and justified needs case through exploration of, and alignment with, the developing energy policy landscape, extensive stakeholder engagement and independent analysis. Project Union is vital in the development of a robust hydrogen infrastructure network to enable adoption of hydrogen across the UK and allow for wider integration with Europe.

As part of the NZASP Re-opener for the Feasibility phase of Project Union submitted December 2022[30], we detailed a needs case for Project Union. As a brief overview Project Union:

- Aligns with UK energy strategy and policy developments
- Aligned with EU (and worldwide) energy strategy and policy developments
- Informs future energy policy developments in industry, power, transport, and heat
- Engages with a wide range of stakeholders to better understand their needs and objectives to better recognise the opportunities and benefits delivered through Project Union
- Utilises the technical knowledge gained from our innovation work across the business, for example the FutureGrid Programme[31]

5.1 St. Fergus to Teesside

The connection of St. Fergus to Teesside through a hydrogen transmission network will be a critical enabler in achieving net zero ambitions for Scotland, and the UK as a whole. It will connect Scotland's surplus renewable hydrogen production with demand centres across the UK and Europe, as well as provide connections to large scale storage in other regions supporting whole energy system planning.

Scotland has made a commitment to reach net zero by 2045, five years ahead of the rest of the UK, with hydrogen being critical in achieving this target. The Scottish Government Hydrogen Policy Statement[32] sets the ambition of at least 5 GW installed renewable and low carbon hydrogen production by 2030 and 25 GW by 2045. The development of a national hydrogen supply chain requires production capabilities that together with concentrated demand and storage locations, can ensure network connectivity. PU: St. Fergus to Teesside will connect renewable hydrogen production in the north of Scotland to demand centres in Grangemouth industrial cluster and Teesside, while connecting potential production surplus to storage sites in other regions of the UK.

This section also enables Scotland to become a hydrogen exporter connecting its production to; Ireland via the Moffat interconnector, England connecting to PU: East Coast and Europe via the Bacton Interconnector as subsequent Project Union sections develop.

[30] Project Union Feasibility Phase Reopener (nationalgas.com)
[31] FutureGrid | National Gas
[32] Scottish Government Hydrogen Policy Statement - gov.scot (www.gov.scot)

5.1.1 Value Proposition

In support of Scotland's hydrogen ambition, Project Union presents the following value proposition, creating opportunities to develop the hydrogen value chain and enabling Scotland and the UK to become leading producers and exporters of hydrogen:

1. **Vast energy resource:** Scotland has an abundance of renewable wind capacity (circa 39% of the UK capacity and approximately 5% of wind resource in Europe[33]). Scotland has a potential pipeline of over 40 GW of offshore wind generation projects[34] and 100 GW renewable electricity supply capacity by 2050[35], enabling the use of surplus electricity for the creation of low-cost renewable hydrogen.
2. **Production and Export potential:** There's a large potential for renewable and low carbon hydrogen production in Scotland, with production estimated to exceed regional demand. The Scottish Hydrogen Assessment estimated that by 2045 approximately 126 TWh of renewable hydrogen could be produced in Scotland and that 94 TWh (74%) could be transported to the UK and exported to other European markets[36]. This hydrogen surplus could supply UK, Ireland (Moffat) and Northern Europe (Bacton) with further Project Union development.
3. **Industry and CCUS cluster presence:** the region includes Grangemouth, one of the six largest industrial clusters in the UK[37], which could employ hydrogen to achieve decarbonisation targets. In addition, St Fergus is considered fit to deliver CCUS Track-2 objectives and retains its status as Track-1 reserve cluster[38].
4. **North to South link to unlock whole energy system benefits:** Gas and Electricity Transmission Infrastructure outlook 2050[39], states that storage plays a key role with hydrogen, being a highly viable solution during low-wind periods by providing non-intermittent supply to support both gas and electricity systems. Connecting the dots between Scotland and Teesside (PU: East Coast) will enable storage access for surplus hydrogen production to unlock whole energy system benefits. Enabled by the development of integrated energy infrastructure, Scottish power, and hydrogen supply to the rest of the UK and Europe could reach up to £15 billion annually by 2045.[40]
5. **Vast transmission and distribution infrastructure**: Scotland has significant installed gas transmission assets, including St. Fergus terminal which receives, processes, and injects over 25% of all UK natural gas[41], as well as distribution assets that can significantly reduce the

[33] Update on Scotland's renewables and wind power potential - gov.scot (www.gov.scot)
[34] Hydrogen action plan - gov.scot (www.gov.scot)
[35] Gas and Electricity Transmission Infrastructure Outlook 2050 (guidehouse.com)
[36] Scottish hydrogen: assessment report - gov.scot (www.gov.scot)
[37] Industrial decarbonisation strategy - GOV.UK (www.gov.uk)
[38] Update to industry on conclusion of the CCUS Cluster Sequencing Track-2 expression of interest - GOV.UK (www.gov.uk)
[39] Gas and Electricity Transmission Infrastructure Outlook 2050 (guidehouse.com)
[40] Scotland Whole Energy System Vision report (Guidehouse, 2024)
[41] Decision St Fergus Compressor Emissions Final Preferred Option (ofgem.gov.uk)

costs of the transition to hydrogen. The North Sea infrastructure further presents an opportunity for hydrogen storage.[42]

5.1.2 Demonstration of need

5.1.2.1 Hydrogen Production

Scotland has vast potential for renewable and low carbon hydrogen production given the abundant onshore and offshore renewable resources. These resources will enable the production of green and blue hydrogen production in connection with CCUS facilities to meet Scotland and UK net zero targets. Estimations in different scenarios[43] indicate a high likelihood that production will exceed regional demand. PU: St. Fergus to Teesside will play an essential role in connecting this surplus production with external market demands across the rest of the UK and Europe.

Green hydrogen production

Scotland has around 39% of all the wind resource in the UK and approximately 5% of Europe capacity, due to its weather, location, and climate.[44] As of December 2023, Scotland's renewable operating capacity from onshore and offshore wind, renewable hydro as well as others such as photovoltaic sources, collectively was 15.3 GW. In addition, the region has further projects with a potential capacity of 25.9 GW as of Q4 2023[45], as shown in Figure 8.

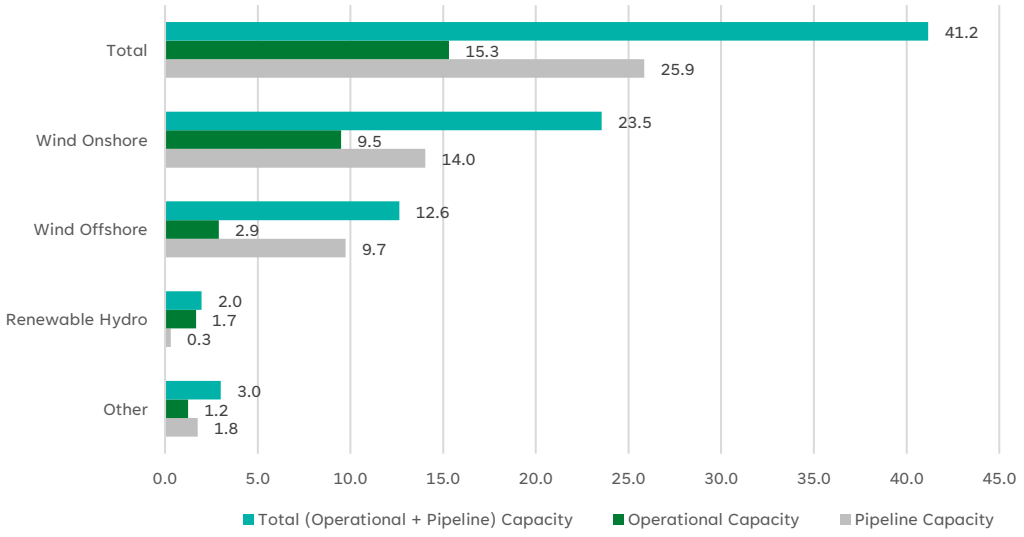


Figure 8 - Scotland's renewable capacity from operational sites and projects on pipeline Q4 2023[46]

Scottish Government has set the ambition for a minimum installed capacity of 20 GW of onshore [47] and 8 -11 GW of offshore wind capacity by 2030[48]. These ambitions align with Scotland's immediate term plan to focus on accelerating renewable hydrogen production from onshore projects that are

[42] Energy infrastructure in the North Sea: a time-sensitive international challenge - European Commission (europa.eu)
[43] Gas and Electricity Transmission Infrastructure Outlook 2050 (guidehouse.com)
[44] Update on Scotland's renewables and wind power potential - gov.scot (www.gov.scot)
[45] Energy Statistics for Scotland - Q4 2023 - gov.scot (www.gov.scot)
[46] Renewable Energy Planning Database: quarterly extract - GOV.UK (www.gov.uk)
[47] Supporting documents - Onshore wind: policy statement 2022 - gov.scot (www.gov.scot)
[48] Offshore wind policy statement - gov.scot (www.gov.scot)

constrained or awaiting grid connection. Thus, allowing onshore wind to establish hydrogen's full supply and value chain, secure domestic demand, and structure a foundation ahead of the anticipated gigawatt-scale hydrogen production associated with offshore wind towards the 2030's.[49] Offshore wind provides the potential for Scotland to deliver its own net zero targets and to contribute to net zero goals for the UK and, potentially, Northern Europe. In total, within Scottish waters there are 2.9 GW of operative offshore wind capacity, 9.7 GW under planning and construction, and 27.6 GW of secured lease options from ScotWind,[50]

Given the extent of renewable resources available, hydrogen production in Scotland has the potential to be a key component of the UK's overall hydrogen supply. The Scottish Government's 2020 Scottish Hydrogen Assessment estimated that by 2045 approximately 126 TWh of renewable hydrogen could be produced in Scotland with approximately 94 TWh exported to the UK and other European markets annually.

[redacted]

[redacted]

[49] Hydrogen action plan - gov.scot (www.gov.scot)

[50] 17 ScotWind project agreements confirmed | Crown Estate Scotland

[redacted]

Blue hydrogen production

PU: St Fergus to Teesside region has a high potential for low carbon hydrogen production given its natural gas supply entry point and carbon storage resources. St. Fergus supplies 25% of the UK's natural gas[53], which represents almost four times Scotland's natural gas demand[54]. In addition, the region has an estimated 46 Gt of CO_2 potential CO_2 storage in Scottish North Sea waters, available as a result of legacy oil and gas infrastructure offering rare access to these storage sites[55].

Acorn in St. Fergus, the most advanced cluster in Scotland, also known as the Scottish Cluster, holds a reserve cluster status under the CCUS Cluster Sequencing Track-1. Due to its maturity, in December 2023, it has been considered by DESNZ for initial engagement to be included in CCUS Track-2, subject to UK Government final decisions.[56]

Scottish Government in its hydrogen Assessment Report indicates that blue hydrogen production potential is expected to reach 2 GW by 2032 and 5 GW by 2045[57]. Among the most relevant blue hydrogen projects are:

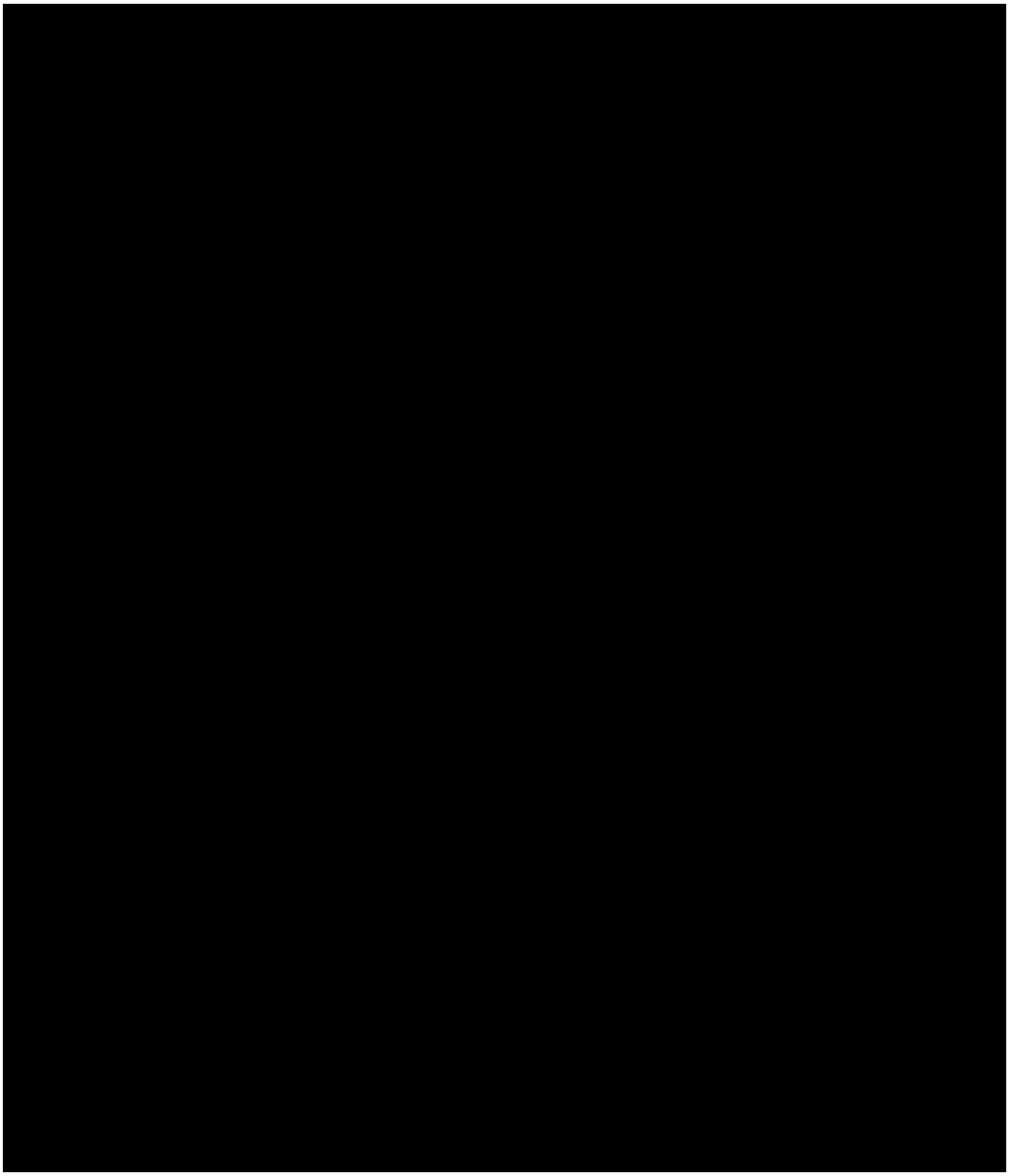
- INEOS Grangemouth Hydrogen Production, with an expected capacity of 850 MW by 2030[58].

[redacted]

These projects will have its carbon dioxide to be transported and stored at Acorn CCUS site.[60]

[redacted]

[53] Scottish Government Hydrogen Policy Statement - gov.scot (www.gov.scot)
[54] Scottish hydrogen: assessment report - gov.scot (www.gov.scot)
[55] Scottish Government Hydrogen Policy Statement - gov.scot (www.gov.scot)
[56] CCUS Cluster Sequencing Track-2: Market update December 2023 - GOV.UK (www.gov.uk)
[57] Scottish hydrogen: assessment report - gov.scot (www.gov.scot)
[58] Ineos Grangemouth Hydrogen Production | Hydrogen UK Project Map (hydrogen-uk.org)
[redacted]
[60] INEOS welcomes UK Government support for Acorn Carbon Capture and Storage Project



The UK and Scottish governments have funded several of the projects considered in Figure 10. Funding programmes include Hydrogen Allocation Round (HAR1), the Net Zero Innovation Portfolio Low Carbon Hydrogen Supply 2, the NZHF - Strand 2, as well as the Just Transition Fund, a Scottish funding programme. Additionally, operational economic viability of these projects is being supported by UK Government with revenue schemes like the Hydrogen Production Business Model (HPBM) and Low carbon hydrogen agreement (LCHA).

5.1.2.2 *Hydrogen Demand*

PU: St. Fergus to Teesside includes one of the six industrial clusters in the UK, Grangemouth[61], responsible for producing 27% of all Scotland's industrial emissions in 2021[62], and provides connectivity with the Teesside cluster. Scotland's largest industrial carbon emitters are involved in activities such as chemical processes, power generation, food manufacturing, cement, and glass.[63] The largest industrial emitters in this zone include INEOS refinery and chemical plant, INEOS's two combined heat and power plants, the Fife ethylene plant (Mossmorran), the Kinneil Terminal within the Forties Pipeline System and Tarmac cement plant in Dunbar[64].

The Scottish Government's Hydrogen Action Plan has identified hydrogen as an alternative resource for difficult to electrify industries, by providing high temperature heat as fuel for industrial processes (e.g., boilers, glass and steel furnaces, cement kilns) or as feedstock for refineries and distilleries. Distilleries were considered the second highest category for hydrogen use cases showing potential for agreements in the Central Belt by the Hydrogen for Scottish Distilleries report's map[65].

The potential hydrogen demand in GWh/year expected from current power stations and industries in the region is explored in Figure 11. Prospective large industry users in Scotland, are mainly located in the Central Belt of Scotland, which include Grangemouth, Fife, and the lower regions to the Firth of Forth.

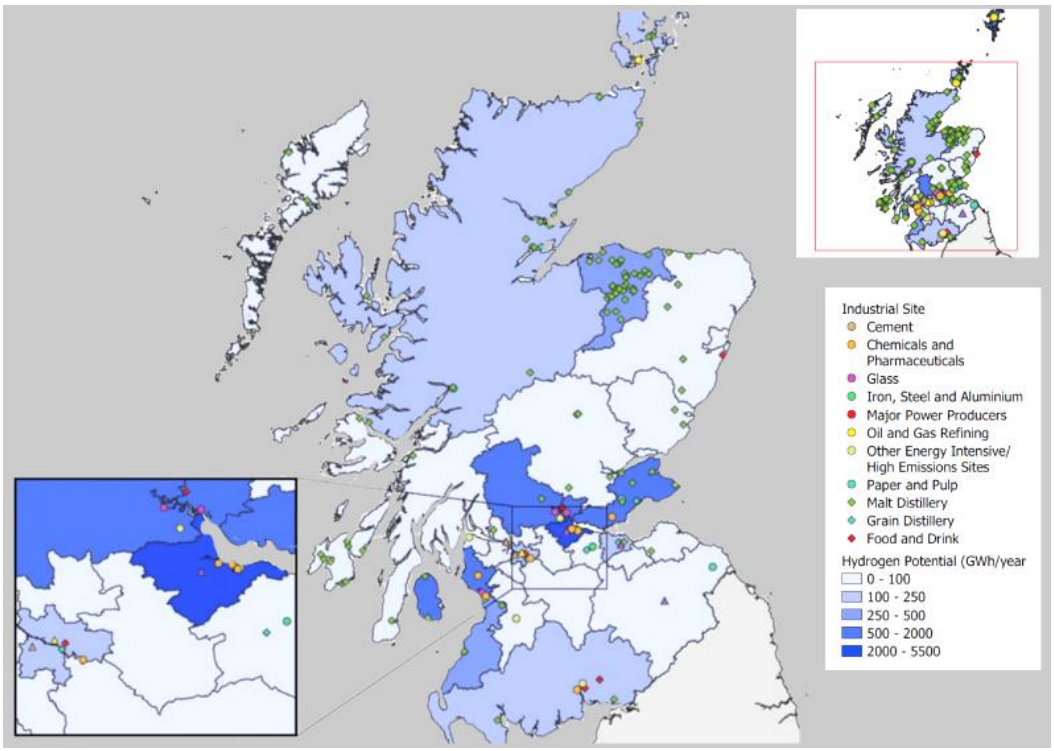


Figure 11 - Heat map showing the GWh/year potential hydrogen demand for industry end use of Scotland[66]

[61] Deep-Decarbonisation Pathways for UK Industry (Element Energy) - Climate Change Committee (theccc.org.uk)
[62] Just Transition for the Grangemouth industrial cluster (www.gov.scot)
[63] Scottish Enterprise, Apr 2023, Hydrogen demand in Scotland: a mapping of industrial applications
[64] Deep Decarbonisation Pathways for Scottish Industries: A study for the Scottish Government (www.gov.scot)
[65] Hydrogen for Scottish Distilleries: a research study for Scottish Enterprise
[66] Scottish Enterprise, Apr 2023, Hydrogen demand in Scotland: a mapping of industrial applications

According to Scottish Enterprise (2023), the potential industrial hydrogen demand of the Central Belt is 8.2 TWh per year, which represents 60% of total potential demand for Scotland[67]. Decarbonisation for industries within this area, through the adoption of low-carbon hydrogen, will be enabled by PU: St. Fergus to Teesside utilising the current NTS by repurposing and capitalising on the infrastructures proximity to industrial hotspots.

Some of these companies have grey hydrogen production facilities for their consumption, which positions this location as a potential hub for CCUS infrastructure and low carbon hydrogen supply and demand[68] for resilience purposes. Hydrogen and CCUS projects in the area include the INEOS Grangemouth blue hydrogen production project, expected to be operational by 2030[69], using hydrogen to fuel the existing combined heat and power plant, the KG Ethylene Plant and Petroineos Refinery. The scope of the INEOS project includes providing additional capability to link the hydrogen production to third parties to support local demand and the development of a hydrogen hub[70]. [redacted]

[redacted]

A key benefit of PU: St. Fergus to Teesside is the potential to connect to other Project Union sections providing these companies with access to storage and supply for any hydrogen imbalance at their sites, providing resiliency to their operations. [redacted]

[67] Scottish Enterprise, Apr 2023, Hydrogen demand in Scotland: a mapping of industrial applications
[68] Scottish Government Hydrogen Policy Statement - gov.scot (www.gov.scot)
[69] INEOS awards contract to Atkins to design its world scale low carbon hydrogen plant at Grangemouth
[70] INEOS at Grangemouth announces plans to construct a Low-Carbon Hydrogen Manufacturing Plant

Additional demand not reflected in the figure above include H100 Fife, a heat trial to provide evidence for the hydrogen heating safety case and UK Government decision in 2026, which will supply hydrogen for up to 300 homes by summer 2025[71].

5.1.2.3 Hydrogen Storage

Geological hydrogen storage is not readily available in Scotland, i.e., there are no onshore salt caverns, and while European Commission suggest that there are potential geological stores in offshore salt caverns and empty gas fields in the North Sea to store hydrogen[72], lead times for developing these are likely to fall outside of Project Union timelines. However, demonstration projects looking for innovation are being progressed in the region, such as H2GO Power which looks at the design and build of a modular hydrogen solid-state storage solution[73] and Port of Aberdeen which is investigating the feasibility of storing hydrogen underwater at the new Aberdeen South Harbour.[74]

[71] H100 Fife | A world-first green hydrogen-to-homes heating network on the Fife coast.
[72] Energy infrastructure in the North Sea: a time-sensitive international challenge - European Commission (europa.eu)
[73] H2GO Power Secures £4.3 Million For Green Hydrogen Storage System In Orkney Islands (forbes.com)
[74] Port of Aberdeen explores subsea hydrogen storage at new South Harbour - Port of Aberdeen

By providing a hydrogen transmission network, PU: St. Fergus to Teesside will provide a route for the potential Scottish hydrogen production surplus to access storage locations across the UK, specifically within the North West and East Coast. Thus, aligning with recommendations from the second National Infrastructure Assessment[75] which indicates that a hydrogen network can enable storage capacity for hubs that do not have developed storage available near-by.

Scottish Government's Hydrogen Assessment surmised that there are significant geological stores in the North Sea to store carbon as an enabler in blue hydrogen production for Scotland and potential European blue hydrogen markets. Acorn CCS, as part of the Scottish Cluster[76], is seeking to utilise offshore geological storage 100km off the coast of St. Fergus. In the Teesside area, the Northern Endurance Partnership have access to the endurance carbon store (saline aquifer), this has the capacity to store 450m tonnes of CO_2 with other potential stores nearby taking potential storage capacity to around 1 billion tonnes[77].

INEOS and Petroineos' hydrogen project at the Grangemouth Industrial cluster have the potential to export captured carbon for permanent storage through the Acorn CCS project. Storegga, an independent UK company pioneering carbon reduction and removal, is the lead developer of the Acorn projects in the North East of Scotland. Storegga has recently signed a Memorandum of Understanding (MoU) with INEOS and Petroineos to develop Scotland's first CCS system by 2027. This partnership is anticipated to play an important role linking Grangemouth's industrials to Acorn CCS - making Grangemouth a key component of the Scottish Cluster. This is thought to advance the competitiveness of the area, and advance the hydrogen economy in Scotland, and the UK.[78]

[redacted]

[75] Second National Infrastructure Assessment - NIC
[76] Back the Scottish Cluster
[77] Northern Endurance Partnership | Net Zero Teesside
[78] Acorn CCS project to partner with INEOS and Petroineos at Grangemouth to capture and store up to one million tonnes of CO2 by 2027 (theacornproject.uk)

5.1.2.4 *Hydrogen Exports*

The hydrogen market in Europe is on the rise coupled with the EU's ambition to import 10 Mt of renewable hydrogen from non-EU sources by 2030.[79] The European Hydrogen Backbone recommends that the European Commission's REPowerEU plan introduces the establishment of import corridors to increase European energy resilience.[80]

The Scottish Hydrogen Action Plan projects state that by 2045 approximately 126 TWh of renewable hydrogen could be produced in the region and of that 94 TWh could be supplied to the UK and other European markets[81]. Moreover, Scotland has natural and technical expertise that can facilitate its path to being a major player in the European export market. The main factors are its extensive renewable resources, proximity to centres of UK and European demand, and established infrastructure such as ports and oil and gas assets.

PU: St. Fergus to Teesside will enable a potential route to market for surplus hydrogen produced in Scotland to the broader UK, Ireland via Moffat interconnector and Europe via Bacton interconnector with further regional Project Union development.

[79] Report 01 - November 2023 - The European hydrogen market landscape.pdf (europa.eu)
[80] European Hydrogen Backbone report - April 2022
[81] Hydrogen action plan - gov.scot (www.gov.scot)

5.2 Externally Supported Evidence

To develop the needs case, we have engaged a wide range of stakeholders across the methane NTS and the hydrogen value chain as well as commissioning independent analysis to help with quantification of benefits. This section summarises the outputs and evidence.

5.2.1 Independent Assessment of Benefits

To develop the needs case, we have commissioned independent analysis to help with the quantification of benefits as well as the development of a phasing strategy, prioritising the order of delivery for subsequent sections of Project Union.

An assessment of the potential contribution of the Project Union full rollout to employment and the economy. This finds that Project Union could directly support £250m – £400m of Gross Value Added (GVA) per annum to the UK economy and 2,500 – 4,500 jobs during the peak construction period. These estimates represent the direct impacts of Project Union only, rather than the net incremental economy-wide impact, as there is insufficient evidence for robust assumptions to be made on leakage and substitution effects, as defined in Green Book guidance[82]

Phasing Strategy. We commissioned [redacted] to develop a multi-criteria phasing tool (MPT) for different Phasing Options (a Phasing Option specifies the order and timing in which the Project Union sections will be built), taking into account decision criteria (including economic criteria, and criteria relating to wider potential benefits). This was submitted to Ofgem March 2024.

Many different phasing orderings are possible. However, certain combinations may be impractical or unfeasible in practice. The following approach was taken to assess Phasing Options in the tool:

- **Understanding the stage of development for each section.** As a first step they reviewed the available information on the location and timing of hydrogen demand, storage, and production. They do this to identify whether there is a clear case (based on consistency with decarbonisation objectives and policy) for a subset of the nine sections to be constructed earlier on.
- **Determining the approach for identifying options.** Next, they considered possible approaches to identify the shortlist of six Phasing Options to assess in the tool.
- **Identifying Phasing Options to test in the MPT.** The last step was to carry out the approach identified out in the previous step to develop the set of Phasing Options to assess in the tool.

The review of the assessment suggests decisions regarding the prioritisation of 'gas on' dates for sections of Project Union could be categorised into two stages, reflecting the readiness of the industrial clusters involved:

Stage 1 ('East Coast / Scotland / North West / Grangemouth-Teesside'): The first stage includes the East Coast, North West, Scotland and Grangemouth-Teesside sections, where the plans for hydrogen production and demand appear to be more advanced. These sections are likely to be most suitable for early prioritisation for 'gas on'.

[82] The Green Book (2022) - GOV.UK (www.gov.uk)

Stage 2 ('Bacton / South East / Southern / Midlands / Wales'): Following the deployment of the first stage, other sections (i.e. the Bacton, South East, Southern, Midlands and Wales sections) could follow. Their review of the existing evidence suggests that plans for hydrogen production and demand are less developed for sections in this second stage.

The distinction of Scotland and Grangemouth-Teesside featuring within Stage 1 of the MPT aligns with our proposal to proceed with PU: St. Fergus to Teesside to progress into FEED.

5.2.2 Delivering Benefit and Avoiding Costs to Energy Consumers

The benefits, and avoided costs, to energy consumers explored in NGT's NZASP Re-opener for the Feasibility phase of Project Union submitted December 2022[83] are still applicable to the next phase of Project Union, explored through this re-opener submission.

A recent study from Guidehouse has shown how across all modelled scenarios, integrated electricity and hydrogen transmission infrastructure planning can realise savings. Early investments are outlined as critical for enabling these savings, with energy system savings of £38 billion, by 2050, possible under the System Transformation scenario[84]. The use of hydrogen in an integrated electricity and gas system ensures that overall infrastructure and system costs can be reduced compared to an all-electric system. The ability to realise these benefits is relying on the viability of repurposing existing NTS assets, with our FutureGrid hydrogen transmission test facility providing evidence for the technical feasibility of NGT's current assets ability to transport hydrogen safely and reliably.

Scotland Whole Energy System Vision report (Guidehouse, 2024) projects that from 2035, offshore wind will become the largest source of power supply for Scotland, producing electricity that will meet its current consumption by over 8 times. Scotland's large offshore wind generation reflects an opportunity of circa £12 to 15 bn/year in 2045 from hydrogen and electricity exports. To materialise this opportunity, both electrical and hydrogen infrastructure is needed by 2035, which means investment is required in the short term. The competitiveness of Scotland's hydrogen exports costs against North Africa's materialises especially when repurposing existing transmission pipeline (approx. 10% cheaper by 2045). Access to hydrogen storages will enhance Scottish hydrogen exports by reducing hydrogen transmission infrastructure capacities by 18% of the total (28 GW), resulting in system-wide capital savings of at least £700m by 2050. This savings would improve the commercial value proposition for European buyers, as well as increase the overall system resiliency in Great Britain.

Project Union: St. Fergus to Teesside will focus on linking this hydrogen surplus production from wind renewable resources, by establishing infrastructure that connects this region to the wider UK, ensuring a connection to demand centres, storage centres, and beyond eventually extending connections to other sections of Project Union with the goal of creating a wider national long term

[83] Project Union Feasibility Phase Reopener (nationalgas.com)
[84] Guidehouse (2023), GETIO: Gas and Electricity Transmission Infrastructure Outlook 2050 (nationalgas.com)

strategic energy resiliency and energy security. This will have the added benefits of enabling grid balance activities and will also avoid curtailment of renewable resources. Having this surplus production accessible to the wider UK will also enable producing and consuming assets to maximise their potential and will foster competition through lower costs that will unlock export potential to Ireland and wider EU.

The proposed activities for the next phase of Project Union, as to include FEED and wider associated activities, will support the realisation of several benefits to existing and future gas network users that repurposing can offer. These benefits are explored in 11.4.

Further to the benefits, and cost avoidance, to energy consumers explored in the previous Re-opener submission, there has been ongoing developmental work with [redacted] on the regulatory framework for hydrogen. A focus area across the second half of 2023 has been the framework and methodologies for the financial treatment of natural gas infrastructure that is repurposed to serve a hydrogen future (or indeed other decarbonisation opportunities such as Carbon Capture Usage and Storage). The output of this work is a set of engagement materials for discussion with Ofgem and DESNZ, to explore the options for a framework that is both practical to implement, and that delivers fair value for methane and hydrogen users, and investors. The key elements of this work are:

1. The primary drivers for the need for an asset transfer framework in terms of societal benefits, and congruence with framework developments across methane, hydrogen and CCUS.
2. A set of principles to guide the development of a framework, aligned to those established for the Hydrogen Transport and Storage Business Model.
3. Challenges and options for establishing the methane RAB value of the assets being transferred.
4. Recognition of the intrinsic value of the assets in question, and the differing perspectives of the “selling” and “buying” parties in this regard
5. The allocation of asset transfer values between users and investors, and an exploration of the need for distinct treatment of the core RAB value, and potential asset transfer premia.
6. The streamlining opportunities afforded by “within entity” transfers vs transfers to external parties

The fundamental objective of this work at this stage is to initiate discussion and debate on this important topic area, as a starting point seeking to achieve recognition of the potential multi-party benefits involved within Regulatory and Government policy. In practice, this is a complex area requiring time to develop and implement. However, timelines for the development of the RIIO-3 and the hydrogen transport business model (HTBM) frameworks are well aligned to enable development of a consistent methodology in advance of a need to “transact”.

5.2.3 Ofgem Engagement

In addition to stakeholder feedback, we also considered feedback from Ofgem throughout the Pre-Trigger engagement, and we have provided a summary playback of the feedback and our corresponding actions in Appendix A.

6. Stakeholder Engagement and Whole System Opportunities

6.1 Engagement Approach

Engagement with our customers has been centred around quarterly one to one meetings, gathering intelligence on the demand, production, and storage capabilities of our customers' current and potential sites. These meetings allowed us to understand the opportunities and blockers arising for our customers, such as government policy decision making, consistency of hydrogen supply, and technical awareness of assets. Further to these individual customer sessions, as part of our Shaping the Future programme, several webinars were held to discuss the future of gas, where customers were able to provide feedback on our proposed future network plans.

To support insights gathered from these meetings, a data request survey, including multiple year intervals up to and including 2037, was provided to all direct connect customers. This survey has allowed for more granular detail to be collated across demand, production and storage capabilities and enabled a clearer understanding of the feasible routing options for pipeline transmission of hydrogen.

We commissioned [redacted] to conduct a hydrogen acceptability study to understand the capability of the assets directly connected to the NTS to overcome issues around technical awareness of assets. This study broke down directly connected assets into archetypes. It shows just under 50% are able to accept either a blend of between 5% - 50% or 100% hydrogen by 2037, which highlighted a series of common themes for lack of commitment to hydrogen. Many companies are awaiting policy decisions before committing to major spend, in addition to requiring further assurance on cost and at this stage, possessing a lack of hydrogen technical awareness. The phased delivery of Project Union will thus help build out the early evidence required to inform these required strategic policy decisions, which supported by the broad scope of hydrogen innovation work, will support customers in the transition to decarbonising their operations with hydrogen.

The engagement completed to date has been used to inform the deliverables set out in the Feasibility phase of Project Union[85]. Customer insights are being widely used across the work packages to ensure that customer needs are at the priority of our proposed plans. These customer insights have been used to inform the Phasing Strategy deliverable, supported by [redacted], to understand the prioritisation of hydrogen development across the NTS. Similarly, these insights have been used to inform the pre-FEED work, where customer demand for a hydrogen network is one of the key criteria used to assess potential routing options.

[85] Project Union Feasibility Phase Reopener (nationalgas.com)

6.1.1 Project Union: St. Fergus to Teesside Customer and Stakeholder Engagement

The regional engagement detailed above has been used to inform pre-FEED activity by highlighting which feeder and new build routing options would facilitate the optimum connection for customers. To support hydrogen network development and maintain operability of the methane distribution network a detailed options assessment (detailed in chapter 7. Options) has been undertaken. Customer engagement and data has been instrumental in determining the most appropriate routing options. Understanding customers hydrogen needs has guided which routing options along the NTS may be the most optimal to meet these needs.

Customer engagement has supported the development of the PU: St. Fergus to Teesside region, where we have utilised our customer relationships, and the insights provided, to shape our understanding of the areas needs and support further development works. Engagement has been undertaken with future potential hydrogen customers in the region, as to determine the scale of supply, demand and storage and the distribution of this across the region.

To ensure we are developing a network for our customers, we collected hydrogen forecasts for production and demand capacity. These forecasts, used in combination with publicly reported data has ensured that potential pipeline routing options are considering the specific strategic connection points.

6.1.2 Project support

Throughout our engagement with key stakeholders, we have ensured synergy between PU: St. Fergus to Teesside and hydrogen projects that other companies are developing this region. Frequent bi-lateral conversations, with these stakeholders, has highlighted the considerable widespread support for PU: St. Fergus to Teesside and the wider Project Union backbone. Letters of Support from key stakeholders have been obtained, which outline that Project Union provides the required infrastructure necessary to enable the connection of sites across the hydrogen value chain.

[redacted] We will continue to work with these organisations and projects to understand how Project Union can support and interact with wider transportation systems to ensure an integrated approach and prevent duplicated efforts.

[redacted]

6.2 Market Needs Analysis

The engagement completed to date has been shared within the Market Insight and Stakeholder Engagement Report (shared with Ofgem 31/01/2024). This collates evidence from stakeholder engagement together with wider market information, which supports the business case for Project Union, while informing three key deliverables as outlined in the NGTs Re-opener submission 2022:

1. Phasing Strategy
2. Preliminary Front-End Engineering and Design (pre-FEED)
3. Hydrogen Market Enabling Activities (including regulation and policy)

In doing so, the evidence collected serves to:

- Support evidence of demand for and requirements from Project Union (including demand for network)
- Provide advice on future stakeholder engagement required to support the project's next steps, including stakeholder mapping and identification of relevant stakeholder networks and stakeholder groups
- Support NGTs ongoing market engagement activities

Moving forwards, the engagement and evidence base will continue to support relationship building between NGT and stakeholders, collecting further information to strengthen the evidence base for Project Union and inform our plans. We will continue to identify new opportunities for NGT and stakeholders to collaborate, such as regional projects to mutually benefit Project Union and the regional development of decarbonisation efforts.

6.3 FEED Engagement Plan

Stakeholder Groups	Stakeholders	Outcomes	Engagement
Directly connected customers including power stations and industrial consumers	• Directly connected power stations and industrial consumers	• Progress relationships • Inform customers about decarbonisation aspirations • Understand customers' decarbonisation plans including flows and timescales • Understand technical capabilities of customers assets including any sensitive users	• Continued direct connect quarterly bi-laterals • 1-1 meetings • Request for Information (RFI)

		• Support engagement with Original Equipment Manufacturers (OEMs) to build H2 readiness and transition plans • Identification of delivery of new collaboration opportunities	
Major energy users not connected to the NTS	• Other large potential customers including additional power stations and large manufacturing sites	• Inform and signpost potential for NTS to support decarbonisation • Understand challenges to hydrogen • Understand segment decarbonisation plans, blockers and landscape	• 1-1 meetings • RFI • Continued Market analysis and horizon scanning • Webinars
Hydrogen Producers	• Potential production projects in the region	• Progress relationships • Understand production plans including flows and timescales • Understand off-take plans and build evidence of demand for network connection • Identification of new collaboration opportunities	• 1-1 engagement • Webinars • Connections engagement
Gas Distribution Network	• SGN • Northern Gas Network • Gas Network Ireland • Mutual Energy	• Progress relationships • Understand decarbonisation plans including flows and timescales • Collaboration opportunities	• Strategic engagement • Regional collaboration projects • Collaborative consumer research
Industrial Clusters, emerging hubs and key regional stakeholders	• The Scottish Cluster • Scottish Enterprise • The Scottish Hydrogen and Fuel Cell Association (SHFCA) • The Scottish Hydrogen Industry Forum • The North-East Scotland Hydrogen Ambition (NESH_2A) • NECCUS • Transport Scotland • Firth of Forth Green Freeport • Inverness and Cromarty Firth Green Freeport • H2 Aberdeen / Aberdeen Hydrogen Hub • The Northern Endurance Partnership • Tees Valley Industrial Cluster • Grangemouth Industrial Cluster (INEOS) • Net Zero Teesside • The Scottish Hydrogen and Fuel Cell Association (SHFCA) • The Scottish Hydrogen Industry Forum • East Coast Hydrogen • Froth Green Freeport (Forth Ports)	• Greater visibility and understanding of the project • Inform with latest research and plans • Develop relationships • Understand whole energy system • Understand decarbonisation plans • Provide opportunity to get involved and have their say in approach	• Continue as leading participant • Industry Conferences • Webinars

	• Teesside Freeport • Tees Valley Hydrogen Transport Hub/ Teesside International Airport		
Local Government	• Scottish Government – Hydrogen Development Team / Net Zero Scotland • Tees Valley Combined Authority	• Greater visibility and understanding of the project • Sharing consenting programme • Inform with latest research and plans • Understand alignment of PU with local development plans and decarbonisation strategies • Continue building understanding of how Project Union support hydrogen opportunities in the region • Sharing insights around regional demand for network • Collaborate on public engagement programme	• 1-1 meetings • Engage on local energy planning • Site visits • Webinars
National Government	• DESNZ • DLUHC (Department for Levelling Up, Housing & Communities) • NESO	• Greater visibility and understanding of the project • Sharing consenting programme • Inform with latest research and plans • Understand alignment of PU with local and national development plans and decarbonisation strategies • Continue building understanding of how Project Union can support hydrogen opportunities in the region • Sharing insights around regional demand for network • Collaborate on public engagement programme	• 1-1 meetings • Engage on national energy planning • Site visits • Webinars
Landowner / occupiers / Interest in land	• Multiple interests who own/occupy/have an interest land required for the scheme	• Progress relationships • Raise project awareness • Understanding of scheme requirements • Understanding of landowner requirements	• Statutory documentation (Land Interest Questionnaires) - Postal • 1-1 engagement meetings • Email/teams calls • Public consultation events
Consents / Environment	• Local Planning Authorities • Statutory Bodies (e.g., Natural England, Nature Scot, Historic England, Historic Environment Scotland, Environment Agency, Scottish Environment Protection Agency) • Planning Inspectorate (PINS) • DESNZ	• Progress relationships • Raise project awareness • Feedback on routing and survey requirements and scope • Guidance / clarity on consenting hydrogen projects • Feedback on Consultation Strategy	• 1-1 Meetings and project and topic workshops (likely to need Planning Performance Agreement for Local Planning Authorities (LPAs) and use of Discretionary

	• The public/ affected communities	• Feedback on routes /impacts to shape the project	Advice Service for statutory bodies) • Environmental Impact Assessment (EIA) Screening and Scoping requests • Consultation material – e.g., website • Public consultation

Table 2 - FEED Engagement Plan

6.4 Whole System Opportunity

The ability to transport and store large quantities of hydrogen will be a central pillar to delivering a net zero energy system, delivering low carbon, secure and flexible energy. As outlined above, we continue to engage with potential customers across the hydrogen value chain to better understand their requirements. They have indicated the benefits of connecting to a robust and secure hydrogen transport network. Adopting hydrogen as part of an integrated gas and electricity whole system ensures that efficiency and flexibility of the energy network are maximised, enabling energy system resilience. As technologies such as hybrid heat systems and hydrogen production from electrolysis begin to advance, there will be an increase in interactions between gas and electricity networks as new interfaces between the systems are created. Through investing in the development of an integrated transmission system, whole energy system savings can be achieved, and regional imbalances between electricity and hydrogen supply and demand can be alleviated.

Outlined in the following reports is the evidence and support for adopting a whole systems approach:

- Independent studies from Afry[86] and Guidehouse[87] have demonstrated that including hydrogen in the future energy system could save £13-24 billion and £38 billion, in overall infrastructure and system costs, respectively, in response to early investment.
- The CCC[88] outlines the requirement for low carbon flexible technologies, including hydrogen-fired turbines, to decarbonise the electricity system, operating as back-up generation and ensuring supply remains reliable. Modelling assumptions for the report are identified to broadly align with Project Union.
- UK's Net Zero Strategy[89] supports the position that a range of cost-effective and efficient solutions, including hydrogen, are required in conjunction with electrification to achieve net zero.
- The UK Hydrogen Strategy[90] outlined the role of hydrogen to be a low carbon energy carrier, that possesses the ability to act as a store of energy to meet demand flexibility needs. Project Union is outlined as a project that will help to inform the evidence base for developing hydrogen network infrastructure.

[86] Benefits of long-duration electricity storage (afry.com)
[87] Gas and Electricity Transmission Infrastructure Outlook 2050 (guidehouse.com)
[88] Delivering a reliable decarbonised power system - Climate Change Committee (theccc.org.uk)
[89] Net Zero Strategy: Build Back Greener - GOV.UK (www.gov.uk)
[90] UK hydrogen strategy - GOV.UK (www.gov.uk)

To develop an interconnected energy system, we need to ensure that appropriate stakeholder collaboration is undertaken, and an agreed approach developed. It will be critical to work with organisations such as trade associations, research groups, industry, and other network owners and system operators, to define common frameworks for assessing whole system solutions. NGT currently participate in Energy Networks Association (ENA) whole systems working groups[91], considering local area energy planning and further related topics. We have also engaged through whole system forums, and through direct engagement, with the National Energy System Operator (NESO). In addition, we have been involved in key innovation studies that look to outline the opportunities for a whole system energy approach. Engagement continues as we further look to integrate the operation of the energy system to enable a resilient and reliable energy landscape, delivering strategically located investments for better network integration.

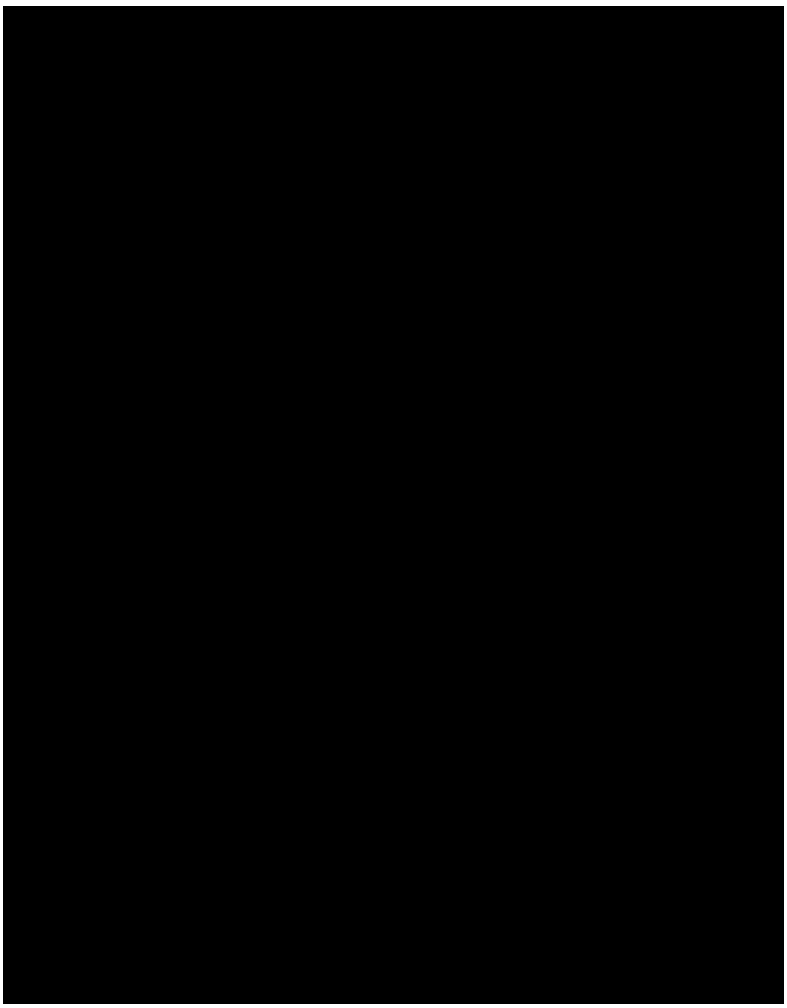
[91] ENA membership – Energy Networks Association (ENA) Transitioning of Gas Networks from ENA membership to Future Energy Networks [FEN] is ongoing.

7. Options

The NTS is at the heart of UK's energy security particularly as we move through the energy transition to net zero, so ensuring it is operated with security and resilience is at the core of National Gas's work. Developing a network solution to connect supply with demand and storage is critical for maintaining a secure hydrogen economy.

There are a range of possible solutions or options that could achieve the objective of connecting these key strategic locations. It is important to have a robust and transparent process to develop and compare options and to assess the positive and negative effects different options may have across a wide range of criteria including environmental, socio-economic, technical, and cost factors.

[redacted]



[redacted]

The options assessment process starts by looking at all of the technically feasible options. These options may cover a very wide geographical area and include a number of different technologies, such as pipelines or compressors, in addition to non-asset solutions. We then narrow down the options through a process of careful analysis and consultation. Having established which of the potential options we think best meet society's needs, if an asset solution is preferred, we focus in on broad corridor locations for any new infrastructure by looking at a range of environmental, socio-economic constraints alongside technical and cost factors. This establishes an initial preferred route corridor for the basis of more detailed development. As we continue to develop the project though FEED we will concentrate on exactly where a new connection might run within this corridor. At this stage we would consult local communities and others, to minimise any impacts on local people and the environment.

Project Union: St Fergus to Teesside is currently at the feasibility phase of development. At this stage, it is appropriate to develop options to the stage of identifying a preferred strategic solution and indicative initial corridor. Further development, assessment and refinement of this corridor, including external engagement, will be conducted as the project progresses to Front End Engineering Design (FEED).

This chapter provides the list of options considered and the selection process undertaken to reach the preferred options. The options assessment has been carried out working with external consultants and specialists as and where appropriate in combination with National Gas teams.

[redacted]

7.1 Consideration of Options and Methodology

Across all options, where asset solutions were required, where the benefits provided are equivalent the option of repurposing pipelines was considered as an alternative to new build pipelines due to the cost, time and environmental benefits associated with repurposing. . An additional option to develop a new build pipeline option will also be carried through while further work is undertaken to approve the release of the pipelines from the methane network and while the technical evidence to demonstrate the viability of repurposing specific assets is being gathered through programmes such as FutureGrid and through asset data collection.

A "do nothing" option was not considered given that there has been a strong indication that a hydrogen transmission network would offer greater benefits compared to a distributed system or one without hydrogen. The option to delay investment could be considered, however, due to the urgent need to reduce greenhouse gas emissions, and in line with decarbonisation policy targets, this was not considered as a viable option. In addition, the nature of the proposed investment could not be addressed via market-based options. There is no such market-based option available which has the potential to be introduced, hence this has not been considered as an appropriate alternative.

The methodology starts with a decision-making process for repurposing, considering:

- Network modelling – the impact on the existing Natural Gas network of releasing methane pipelines for hydrogen (capability assessment)

- Customer and Stakeholder - the needs and impacts on existing methane customers and potential hydrogen customers of releasing pipelines for hydrogen. Where a potential repurposed section has offtakes that require a continued methane supply, that section would be
- Engineering Decision Support Tool – technical suitability of pipelines for hydrogen; a technical risk-based approach using existing asset data

If a continuous network could not be established through repurposing existing pipelines, then a strategic options assessment was conducted to connect the repurposed section with new pipelines. A long list of pipeline and non-pipeline solutions was developed. These options were then scored and ranked to create a short list of options for detailed assessment.

7.1.1 Network Modelling – capability assessment

To assess if a pipeline can be removed from the NTS and used in the future hydrogen network we need to understand the impact this will have on the remaining methane network. This is done, for each option in turn, by removing the pipelines proposed for repurposing from the methane network model and assessing the capability of the network without these pipelines. The capability of the network is its operational ability to meet network obligations. These obligations include both commercial capacity release obligations and statutory licence obligations regarding network safety and security of supply. The key Statutory obligation driving NTS capability is the Pipeline System Security Standard, often referred to as the "1 in 20 design standard". This licence condition requires the Gas Transmission Network be designed to meet the highest demand seen on 1 day in a 20-year period.

The repurposing assessment is an iterative process using previous results to eliminate options and develop the best performing options. In this assessment, best performing can be defined as the option that has the least impact on the NTS (methane network) capability. The output of this analysis determines pipeline sections that could be released from the methane network as candidates for repurposing for hydrogen, which in turn highlights areas where new build pipelines are required.

To determine the optimum route for the Project Union backbone for Pre-FEED, options were considered using the proposed East Coast Hydrogen preferred route as a starting point and then assessing the impact of removing additional NTS feeders outside of the East Coast region shortlisted for repurposing. Preliminary investigations examined possible routes connecting St Fergus terminal to the proposed East Coast Hydrogen network.

7.1.1.1 Capability Assessment

7.1.1.1.1 Scotland

[redacted]

[redacted]

[93] [redacted]

[redacted]

7.1.1.1.2 Grangemouth to Teesside

[redacted]

7.1.1.2 Capability Assessment Conclusion

7.1.1.2.1 Scotland

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

- [redacted]
- [redacted]
- [redacted]

[redacted]

[redacted]

[redacted]

[redacted]

7.1.1.2.2 Grangemouth to Teesside

[redacted]

[redacted]

Initial analysis has not identified any capability reduction from this repurposing that would require compensatory investment in the methane network. This will be reassessed during the next stage of analysis.

From a GB perspective, any capability reduction associated with repurposing these sections of the NTS for Hydrogen must be assessed against the value added by avoiding the environmental and cost impacts associated with new build options.

This work has fed into the next stage of option development, providing a starting point for repurposed sections. Least capability impact, equivalent alternatives and less preferred equivalent alternatives have been considered to continue the repurposing assessment by Engineering Decision Support Tool (DST). It also provides an understanding of where new build routes would be required and the routing to be assessed.

7.1.2 Customer and Stakeholder insight

Insights from customer and stakeholder engagement (see 6. Stakeholder Engagement and Whole System Opportunities) have provided an understanding of customers future needs for methane and hydrogen. This engagement identified key national strategic areas of hydrogen demand and production:

[redacted]

These insights establish a market need to explore infrastructure options in the region connecting hydrogen production, demand and storage. Throughout assessment of the routing options, customer and stakeholder insights are continually assessed to ensure market needs are met.

7.1.3 Engineering Decision Support Tool

An assessment of suitability for converting an existing methane pipeline to transport hydrogen was conducted using the Technical DST, a tool developed by [redacted] in line with guidance from PIE[94].

[redacted]

[redacted]

[redacted]

[redacted]

[94] Hydrogen Repurposing Process for the NTS 2023 (smarter.energynetworks.org)

[redacted]

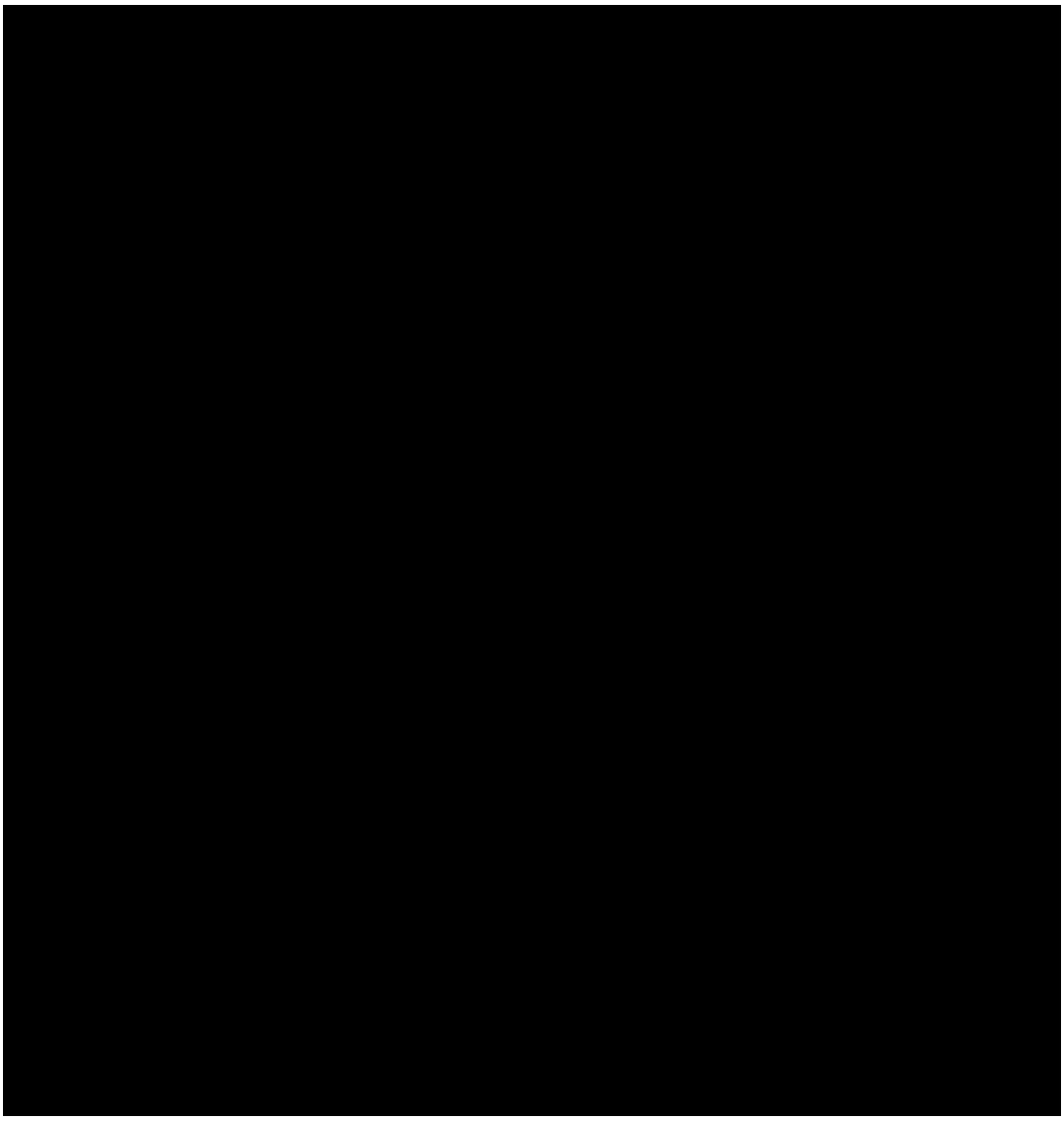
The six criteria the DST used to assess the risk of repurposing an existing methane pipeline to a hydrogen service were: Material Grade, Design Factor, Hydrostatic Pressure, Hydrogen Maximum Operating Pressure (H2 MOP), Fracture Toughness, Defects and Metallurgy Issues. A lower final assessment score from the DST represents a lower risk of repurposing. In the Scotland section, Feeder 24 is the only section of pipeline that has an X80 material grade, but this was not a candidate for repurposing. There are no repurposing candidate pipelines within the Grangemouth to Teesside section that have a material grade of X80.

Pipelines with X80 material grade have potential limitations when repurposing to hydrogen, as detailed in IGEM/TD/1 Edition 6, Supplement 2, and had an overall higher score than pipelines with lower material grades. Work is underway to understand if there are ways to mitigate these limitations however there is no guarantee that this work will reach a positive outcome on the timescale required for this project. Therefore, pipelines with X80 have been discounted for repurposing in this study.

The data used to develop the DST was existing asset data collected for assessing the health of pipelines for methane service. As PU: St. Fergus to Teesside progresses through the next phase of work, additional and more granular data specific to hydrogen repurposing, will need to be collected. The DST will be updated as this becomes available.

For example, enhanced In-Line Inspections (ILI) using novel techniques will be required to gain additional data on pipeline condition. The data captured will be over and above that required for BAU methane operation. These inspections will from part of the scope of works for FEED. More detail of works required can be found in 8.2 Formulation of Scope- Operations work package.
The DST can be updated to capture all new data and consider revised results of the assessments undertaken during the FEED phase.

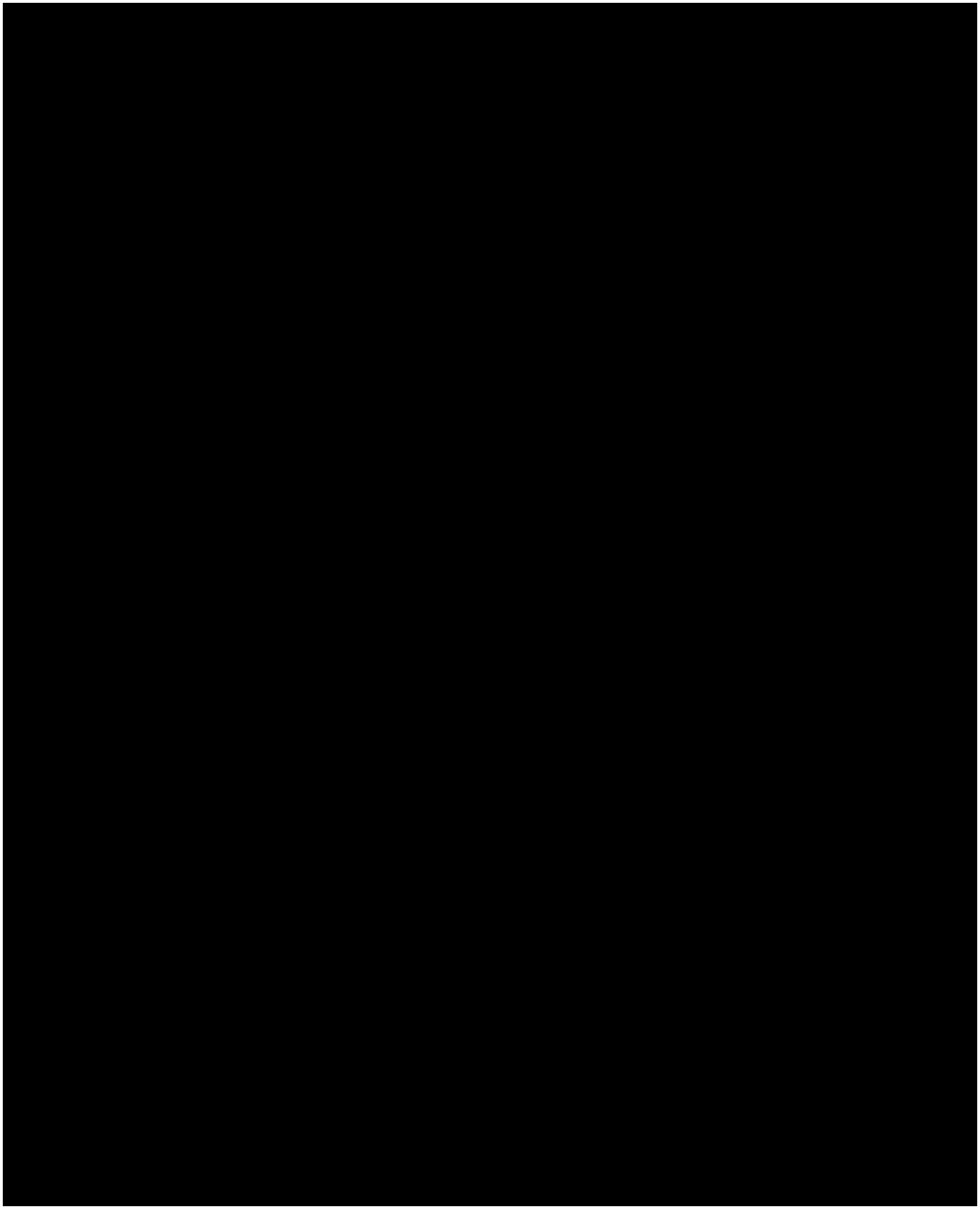
7.1.4 Repurposing Candidate Feeders



The results of the methane network capability modelling, and customer and stakeholder impact were considered alongside the DST scoring to determine the preferred pipelines for repurposing.

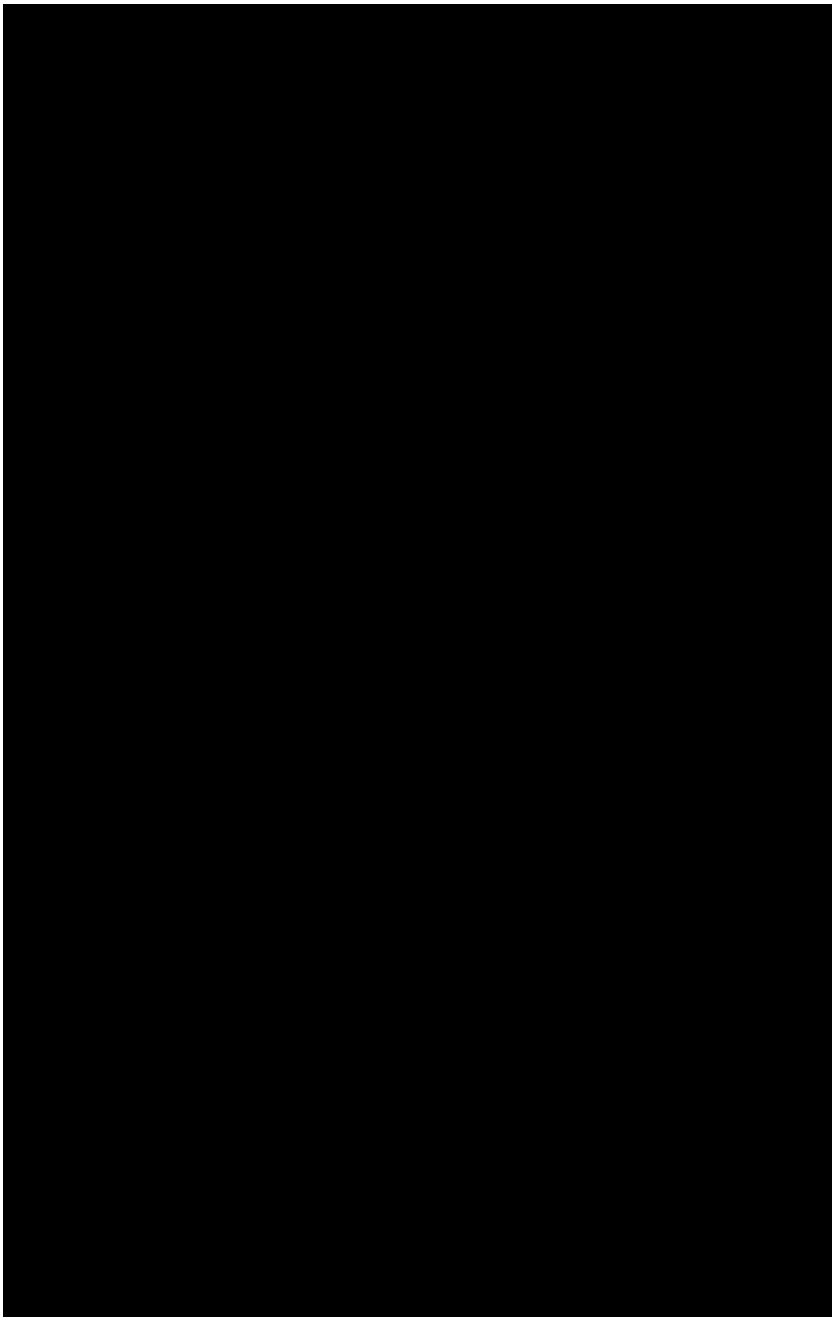
In these instances, only one of the pipelines in each of the parallel sections can be repurposed. This is driven by the need to maintain security of supply and capability on the NTS. From a Hydrogen perspective, repurposing either Feeder from each pair would provide sufficient capability to meet both current forecast flows and a level of future expansion.

Considering the DST scores, methane network capability impacts and customer and stakeholder needs, the preference of which pipeline to repurpose has been assessed in the strategic options report, [redacted]



7.2 Hybrid Strategic Options

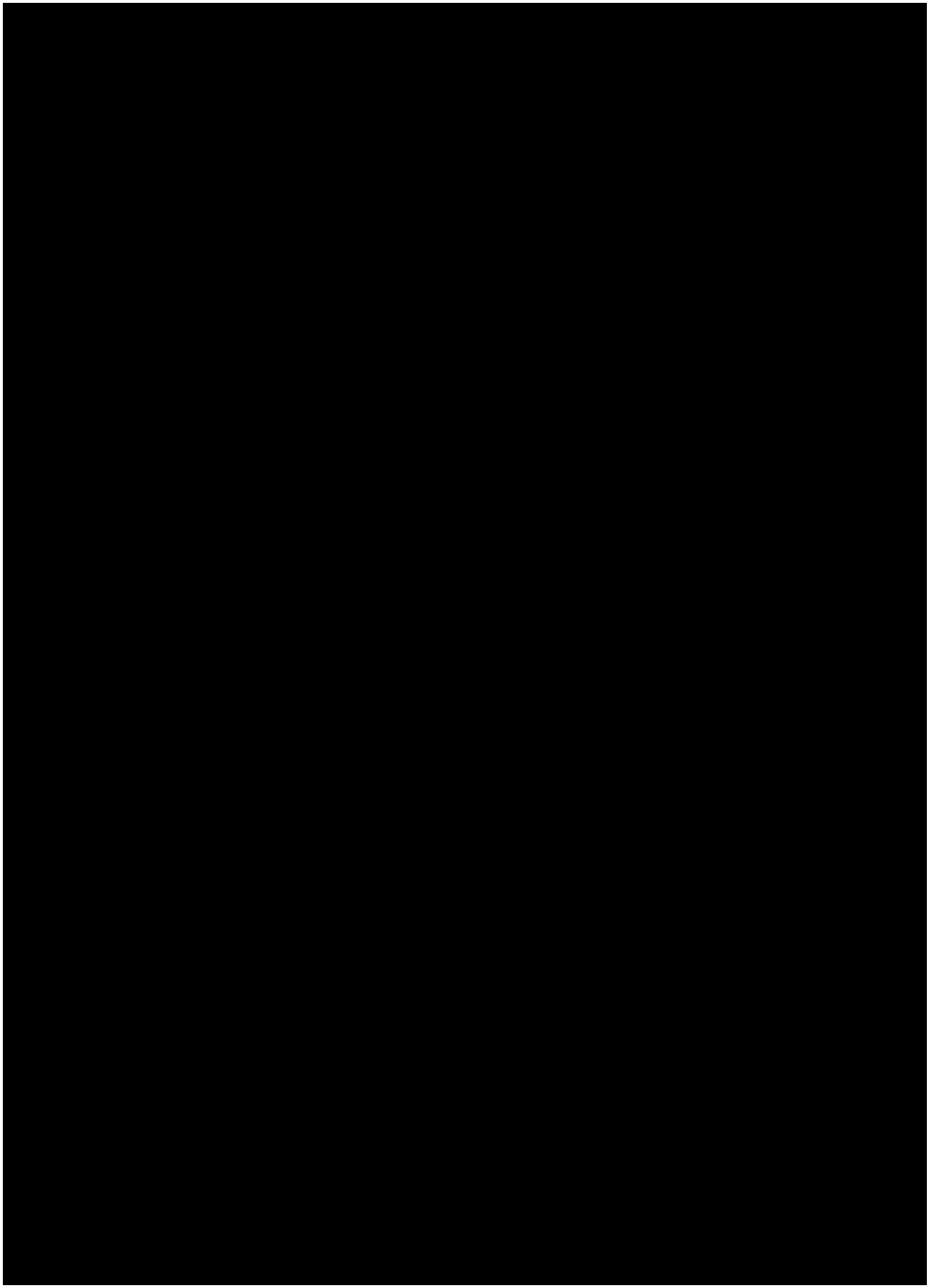
The appraisal's primary objective was to evaluate the technical feasibility of repurposing existing assets where possible. [redacted] Therefore, strategic options need to be considered on how to achieve the primary objectives of creating a complete UK hydrogen backbone that connects national strategic areas. This will result in a pipeline route consisting partially of repurposed pipeline and partially new build. We have termed this as a 'Hybrid' layout, and thus the Strategic Options developed under this theme have been termed 'Hybrid Options'. [redacted]

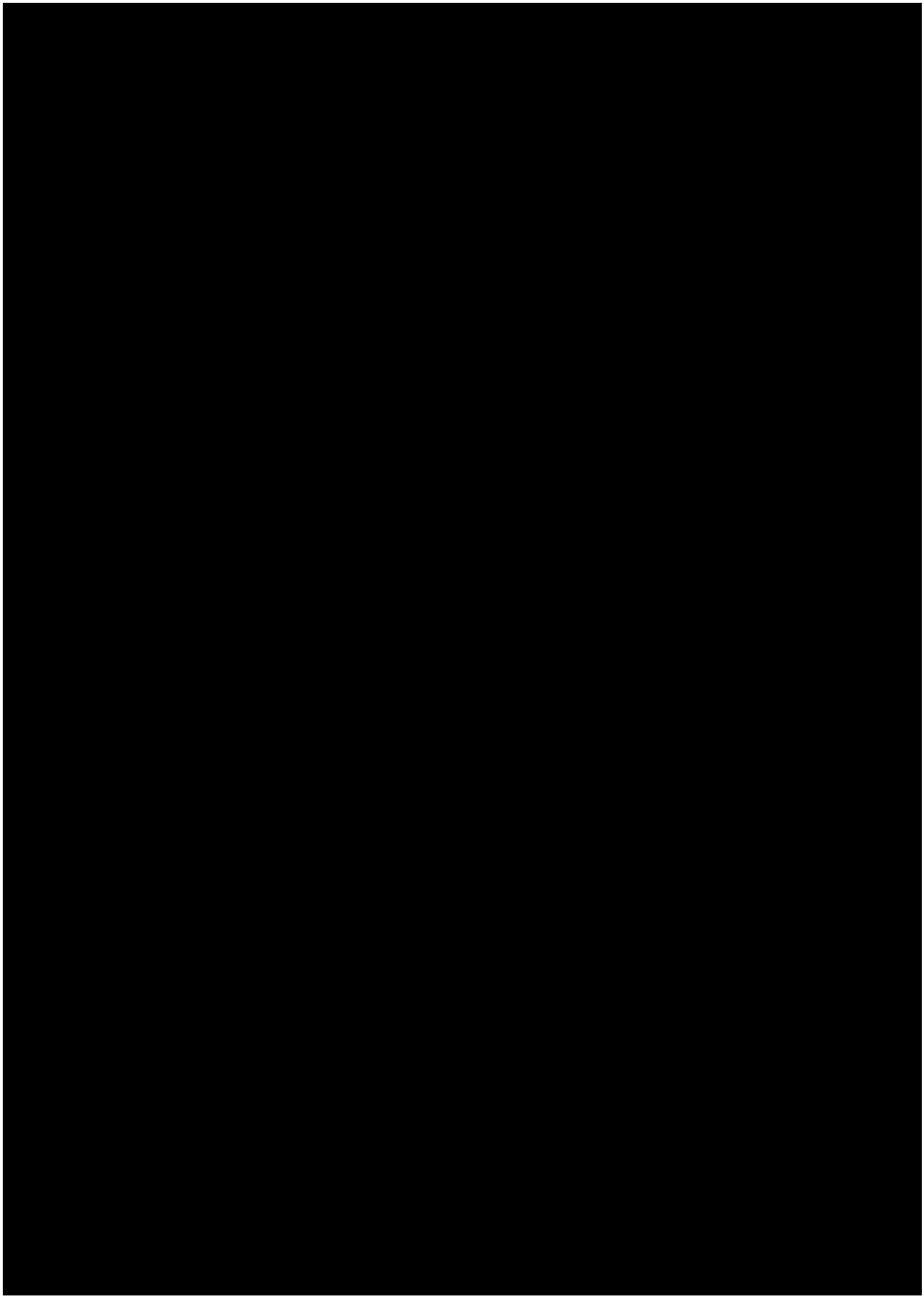


7.2.1 Hybrid Strategic Options Long list

The long list of hybrid strategic options looks at how to achieve the objective of creating a UK hydrogen backbone that connects national strategic areas. In the context of St. Fergus to Teesside this translates to connecting the repurposed sections of pipelines to create a continuous system connecting the national strategic areas and, where efficient, options will connect to strategic connection points.

The strategic options were developed separating the sections in two: St. Fergus to Grangemouth and Grangemouth to Teesside.

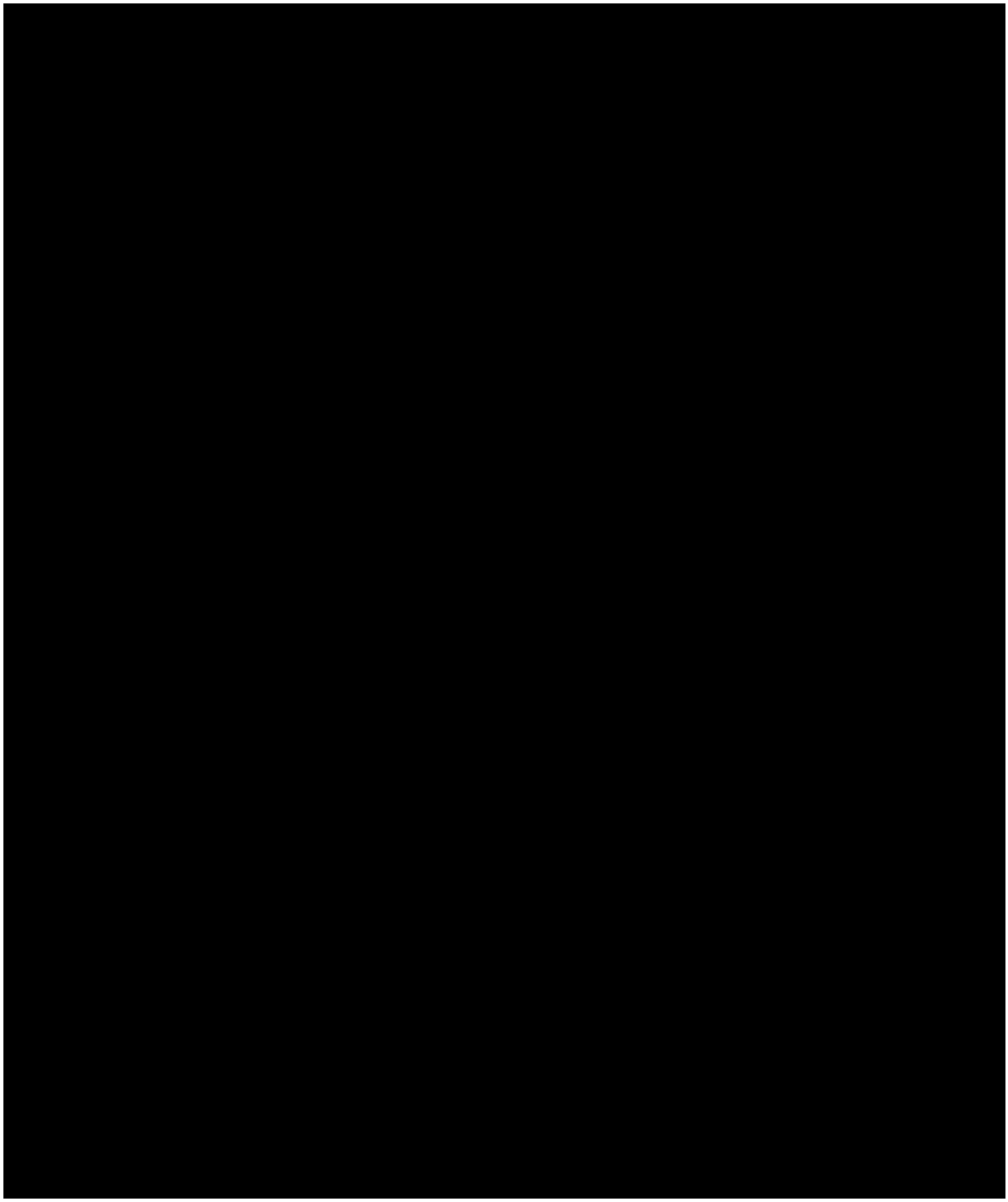


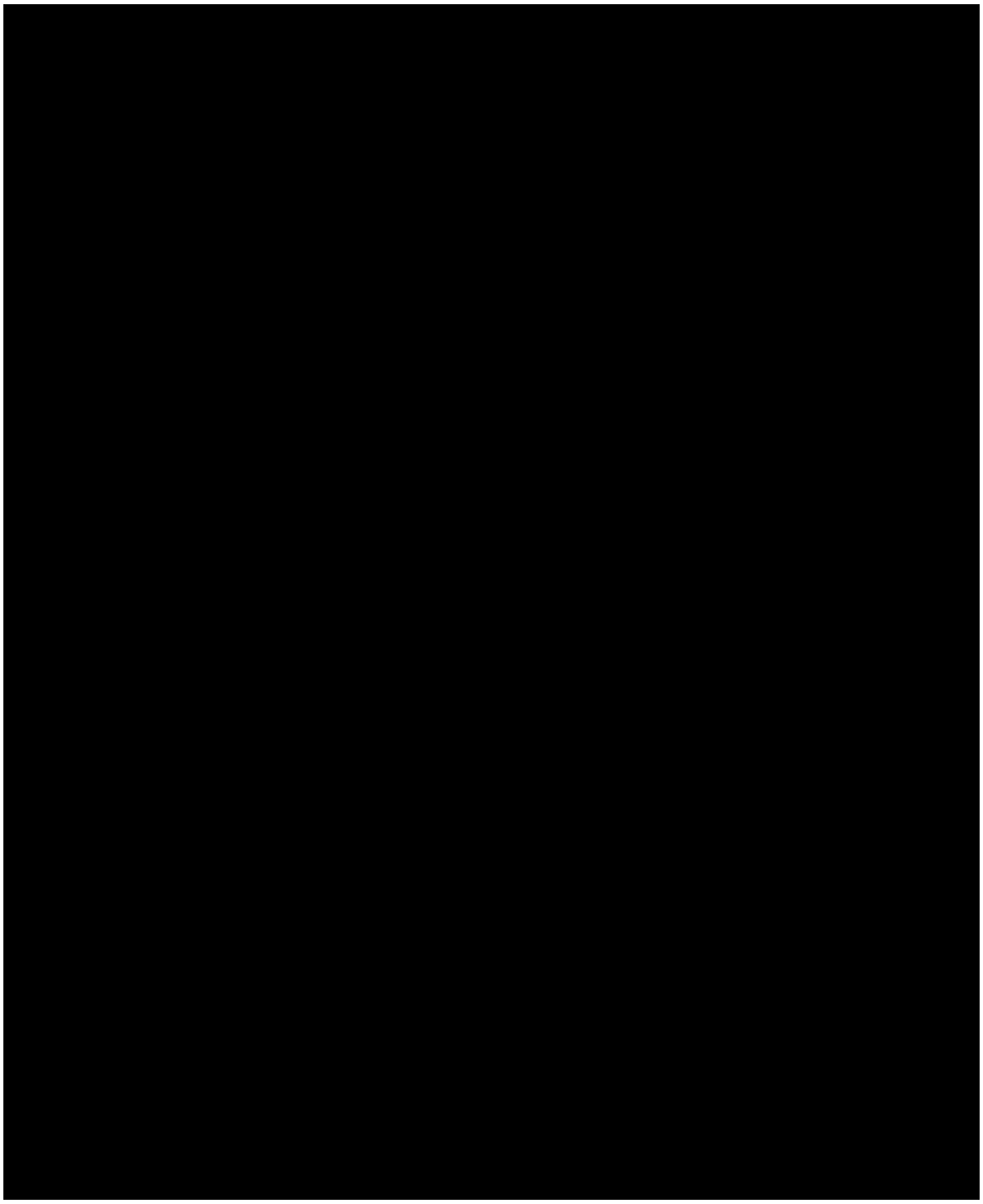


[redacted]

[redacted] The long list was assessed against weighted criteria detailed in Table 6.

[redacted]





Criteria	Description	Weighting	Weighting Justification
Known Customer need	The option's ability to connect known customer need (demand, production and storage).	**20**	Developing a network that meets customers' needs is a key driver for the project as without this, there would be no needs case for the project. This criterion therefore receives the joint highest weighting.
Future Connections	The option's ability to provide future connections and network development. This is characterised by the route passing known industrial areas.	**10**	Ensuring the option supports future customer connections is important, but it receives a lower weighting due to the inherent uncertainty around future need and relative importance compared to current known customer need.
Project Union Objectives	The extent to which the option supports the objectives and goals of Project Union to creating a continuous network which connects nationally significant hydrogen production to storage and demand, delivering resilience and interconnectivity to the UK hydrogen economy.	**20**	With the government acknowledging the need for a core hydrogen network as a key contributor to achieving net zero, ensuring that St. Fergus to Teesside facilitates this is a primary objective. This criterion therefore receives the joint highest weighting.
Technical Complexity	Assessment of the complexity of engineering and construction of the option.	**15**	The Technical complexity of the project has a significant impact on its constructability. However, it is not in itself a key determining factor in achieving Project objectives. It therefore receives a moderate rating.
Environment, land use and consenting	Assessment on the environmental impact and ease of consenting an option. This takes into consideration land rights required for permanent above ground assets.	**15**	The consentability of the project is an important factor however, it is not in itself a key factor in achieving project objectives. It therefore receives a moderate rating.
Capital Expenditure (CAPEX)	The capital expenditure of the option.	**10**	Capital expenditure is an important factor. However, as CAPEX and OPEX are considered separately, each

			individually receives a lower weighting. This ensures that total cost does not have an undue influence on option selection.
Operational Expenditure (OPEX)	The relative operational cost of an option. This includes inspection, maintenance and resources required. This considers the OPEX impact on customers too.	**10**	Operational expenditure is an important factor. However, as OPEX and CAPEX are considered separately, each individually receives a lower weighting. This ensures that total cost does not have an undue influence on option selection.

Table 6 - Criteria Description and Weighting

[redacted]

[redacted]

While GT - Hybrid A scored more favourably overall at this stage, there is the case to consider whether the benefit additional spurs to strategic locations would outweigh the cost, this will need to be considered as the Hydrogen market develops and the scale and viability of customers plans become clearer.

7.2.2 Preferred Hybrid option

7.2.2.1 Scotland

Scotland - Hybrid G is the preferred strategic option for St. Fergus to Grangemouth section which ranked the highest in the criteria assessment. Option Scotland - Hybrid G received the highest score for Known Customer need as it would connect all the strategic connection points identified through the customer and stakeholder engagement that we have sufficient data evidence to support building to within the timelines required. This option also scored highest for future connections, partly due to the benefits of repurposing [redacted], but also due to the new build pipeline sections to the strategic connection points providing good access to future hydrogen projects in the region. [redacted] This option also ranked well in technical complexity, receiving a 4 out 5. It received this score as this option consists only of onshore pipelines which is technically less complex compared to the other options that included major crossings, offshore pipelines and transport terminals.

To develop the indicative route corridors for Scotland - Hybrid G a multi criteria analysis (MCA) was completed to determine the least constrained path between repurposed pipelines and strategic connection points.

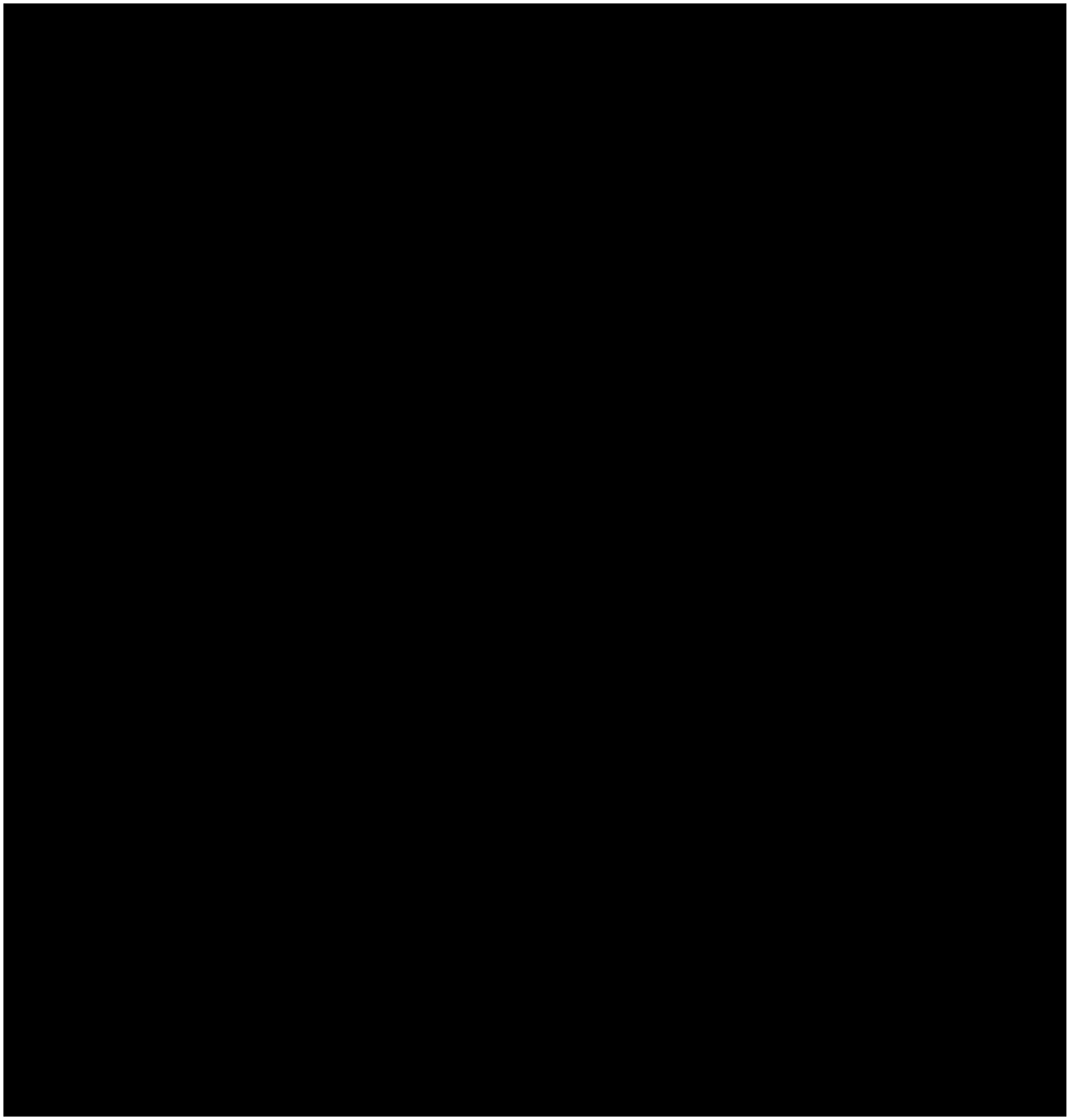
A core option was established that connected all the strategic location points, Scotland - Hybrid G.0, and variations of this option, Scotland - Hybrid G.1- G.5, present options with major spurs removed and variations in repurposed feeders. [redacted]

[redacted]

[redacted]

[redacted] The variance between Scotland - Hybrid G.0 – G.5 is the progressive removal of spurs to strategic connection points, broadly removing them in order of production size and relative proximity to [redacted]. The purpose of this was to develop the construction route costs for building out a [redacted] spur to each to support the CBA. Demonstration of a feasible route out to new production sites will support further engagement with customers and stakeholders in the early phases of FEED and will test the validity of routing new build out to more remote sites. The assumption of [redacted] for all new build will also be revisited, ultimately to provide the customer with choices for how to connect their site to a hydrogen network. Having a variation with and without a connection to the Project Union network assists in understanding the cost and impact of this connection option.

[redacted]



7.2.2.2 Grangemouth to Teesside

GT - Hybrid A is the preferred strategic option to connect Grangemouth to Teesside which ranked the highest in the criteria assessment. It delivers a continuous network that would connect Teesside to Grangemouth, while also connecting the Ireland interconnectors at Moffat, the National Strategic Area for the section. This option is made up of fully repurposed pipelines and therefore, has no requirement for any new build. These factors meant that Hybrid A scored the maximum against Project Union objectives, technical complexity, environmental, land use and consenting, CAPEX and OPEX criteria. GT - Hybrid A did score 4 against known customer need and 3 against future connections, this score was bettered by alternative options, such as GT - Hybrid C, which offers a similar solution but with the addition of spurs to connect strategic connections. While GT -Hybrid A scored more favourably overall at this stage, there is the case to consider whether the benefit additional spurs to strategic locations would outweigh the cost, this will need to be considered as the Hydrogen market develops and the scale and viability of customers plans become clearer.

To develop the indicative route corridors for GT - Hybrid A an MCA was completed to determine the least constrained path between repurposed pipelines and strategic connection points.

A core option was established that connected all the strategic location points, GT [redacted]

7.3 Full New Build Strategic Options

As described earlier in this section, repurposing pipelines is recommenedover new build pipelines due to the cost, time and environmental benefits associated with repurposing. However, due to the requirement to gather additional data from hydrogen specific in-line inspection of the proposed repurposed pipelines, and the need to progress with design concurrent to ongoing innovation studies and engineering policy developments, there is a risk that current repurposing assumptions and findings regarding repurposing could later be invalidated and make repurposing infeasible.

This may for example arise from the findings of enhanced pipeline inspections, methane or hydrogen transient network analysis or ongoing innovation projects, as well the need to progress with design concurrent to ongoing innovation studies and engineering policy developments.

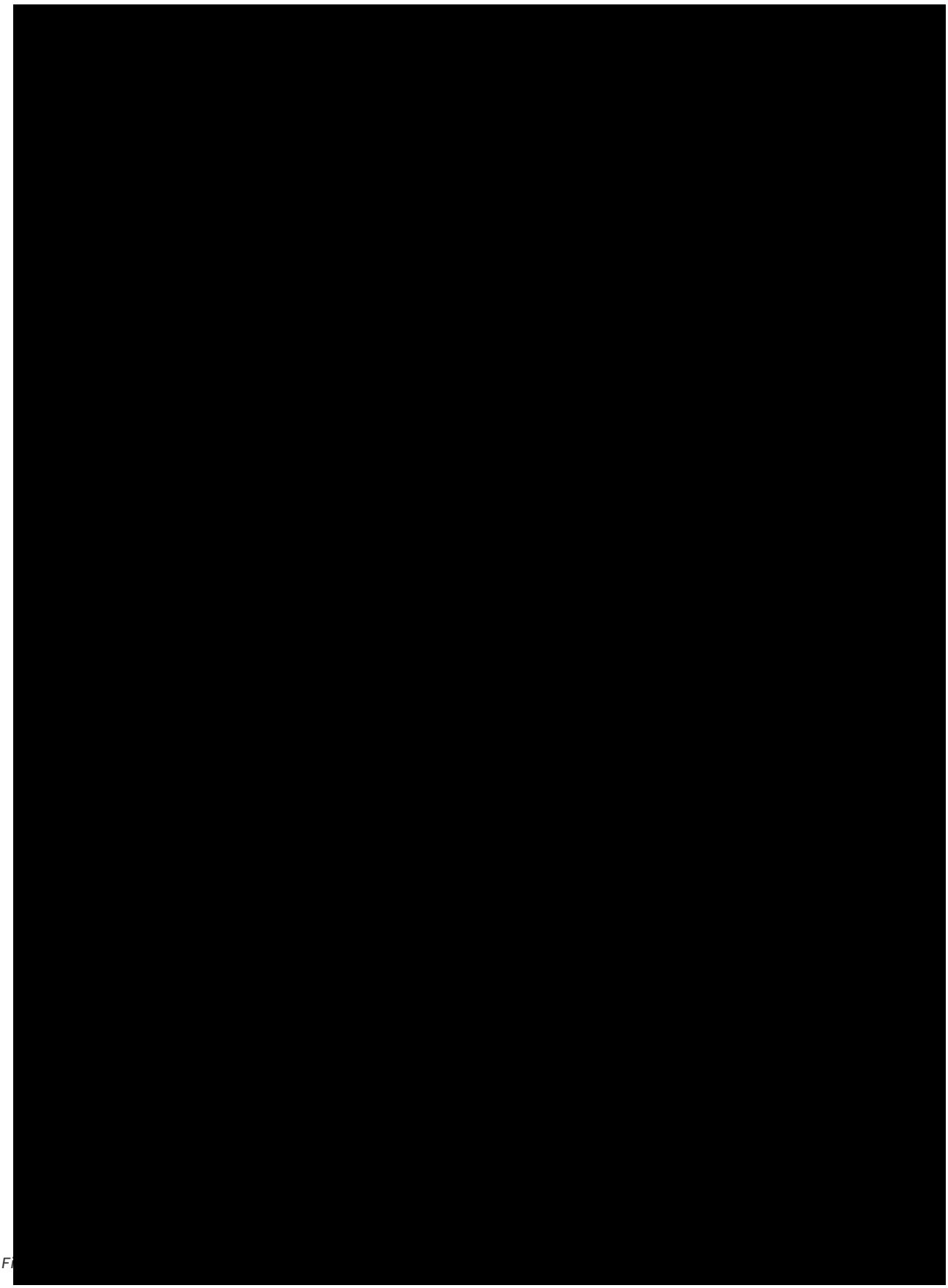
The likelihood of this risk is low, but the consequences of this risk materialising could be significant, most notably having a major impact on the project timeline and thus the ability to facilitate decarbonisation objectives in the St. Fergus to Teesside region. As described previously, in order to mitigate this risk we have carried out some high-level optioneering to consider the technical feasibility and potential cost of a full new build option, identify an indicative new build corridor (to be developed further during FEED) and to provide data on which to base a credible bottom-up FEED cost estimate.

7.3.1 Full New Build Strategic Options Long list

7.3.1.1 Scotland

The long list of Full New Build options looked at how to achieve the objective of creating a UK hydrogen backbone that connects national strategic areas without repurposing existing NTS

pipelines. Non-pipeline hydrogen transport options (shipping, road transport etc.) were also considered in the long list. [redacted]



Fi

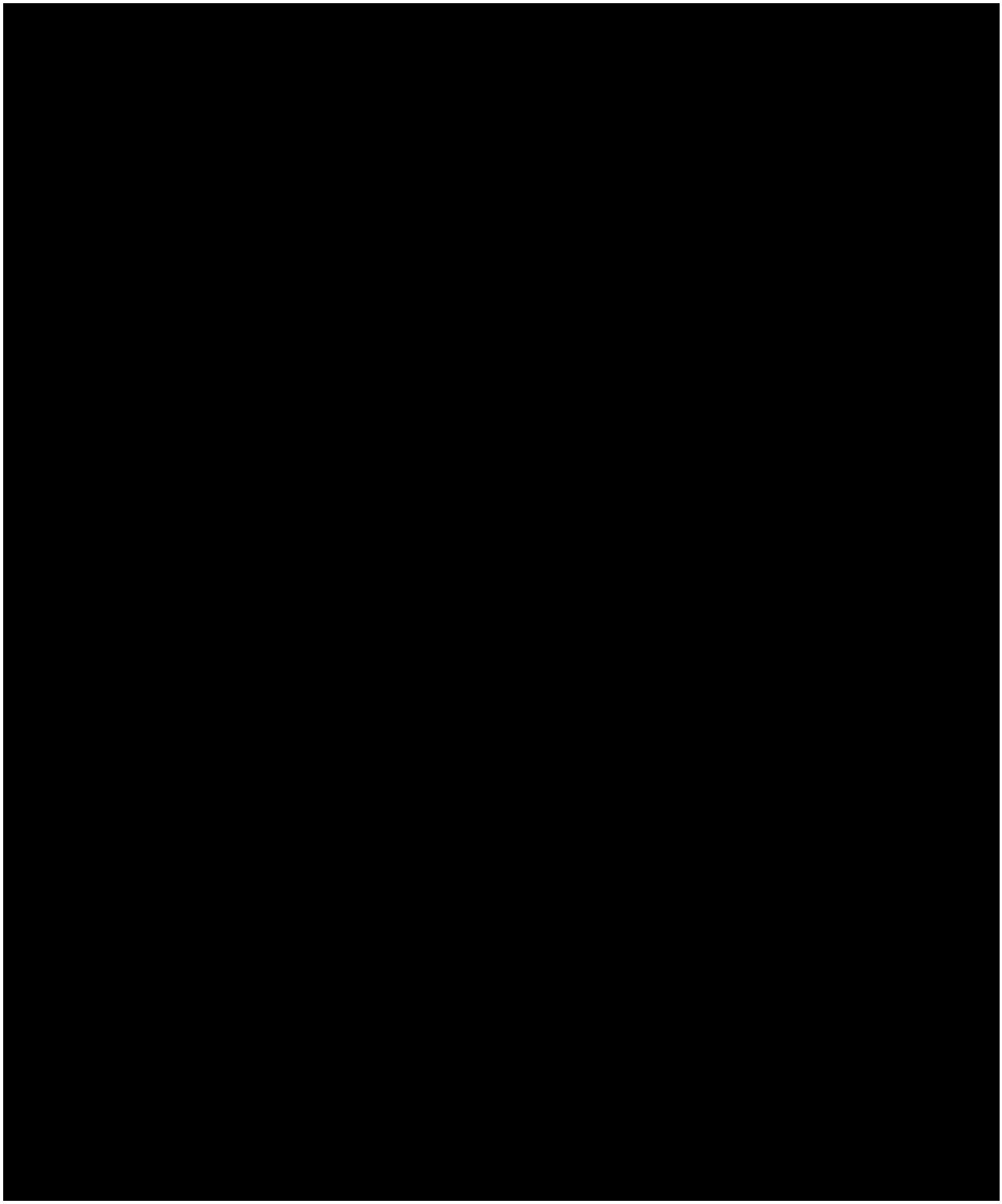
[redacted]

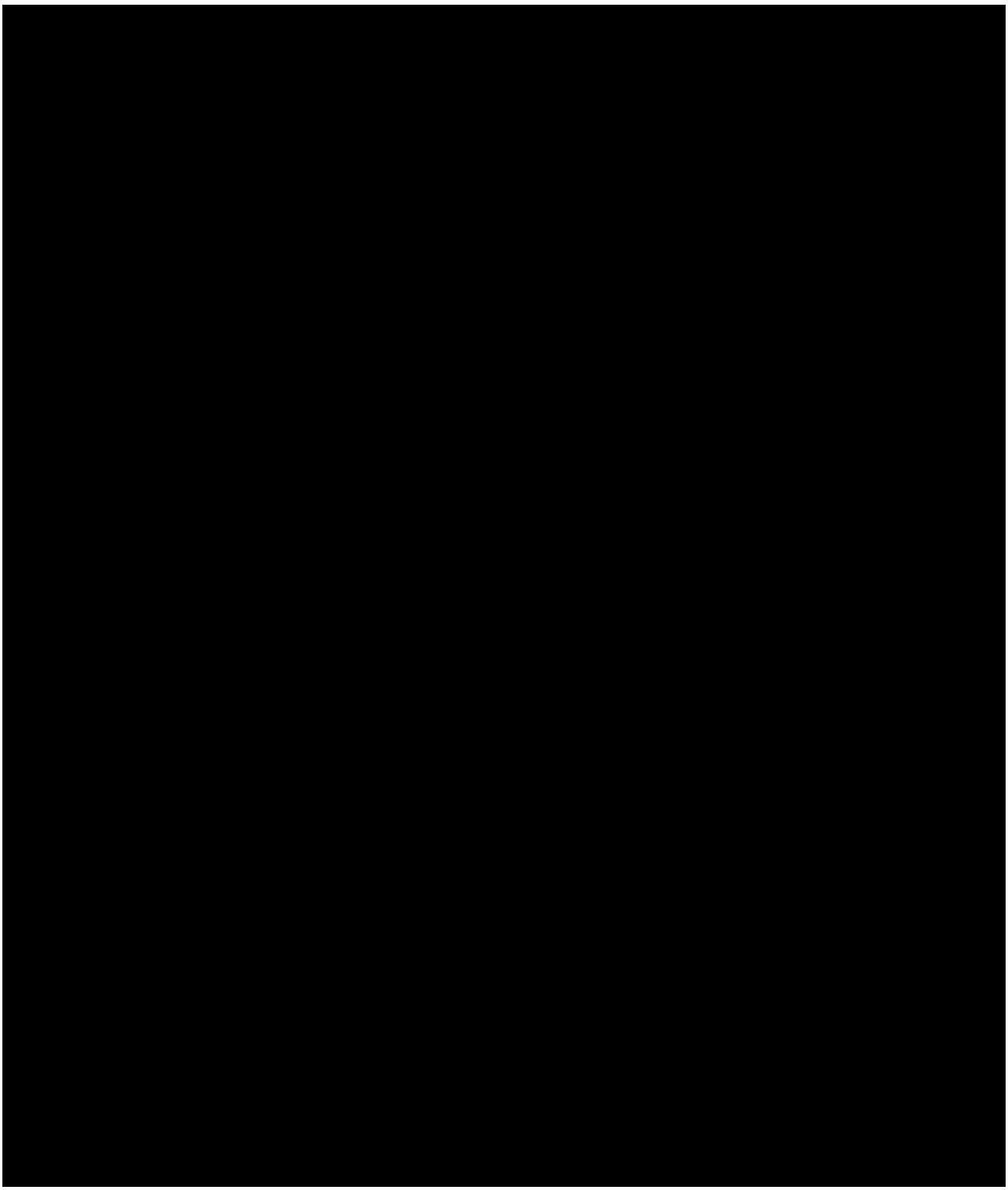
- Non-pipeline solutions ranked low due to high technical complexity and high CAPEX and OPEX.
- Offshore options ranked low due to high CAPEX compared to onshore pipelines and scored low in future connections as they limit the ability for new customers to connect to the network outside of the national strategic areas.
- The options that ranked the highest were onshore pipelines that created a continuous network connecting the national strategic areas via the strategic connection points, as this best aligned with primary Project Union strategies and the customer needs cases identified through direct engagement.

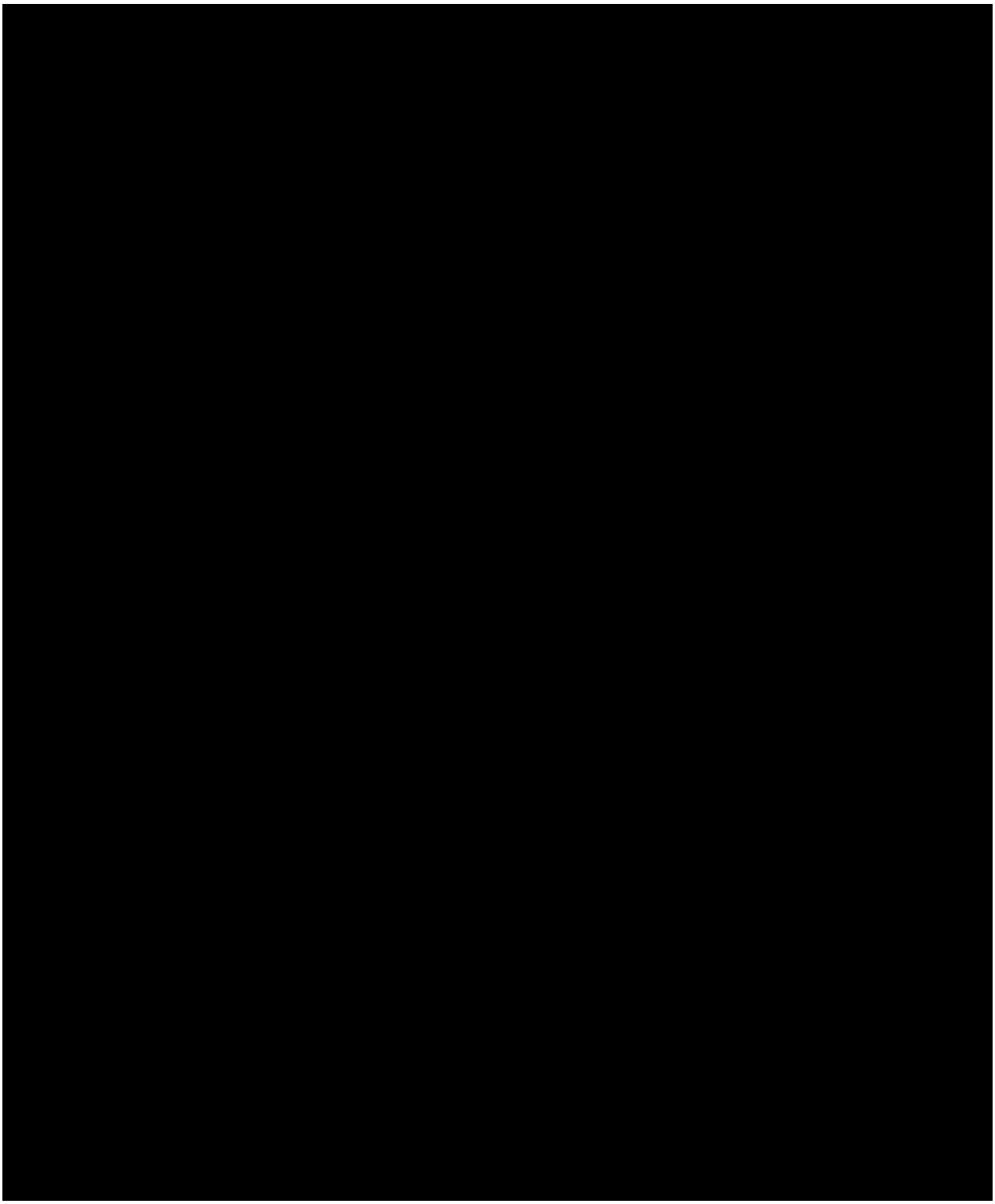
[redacted]

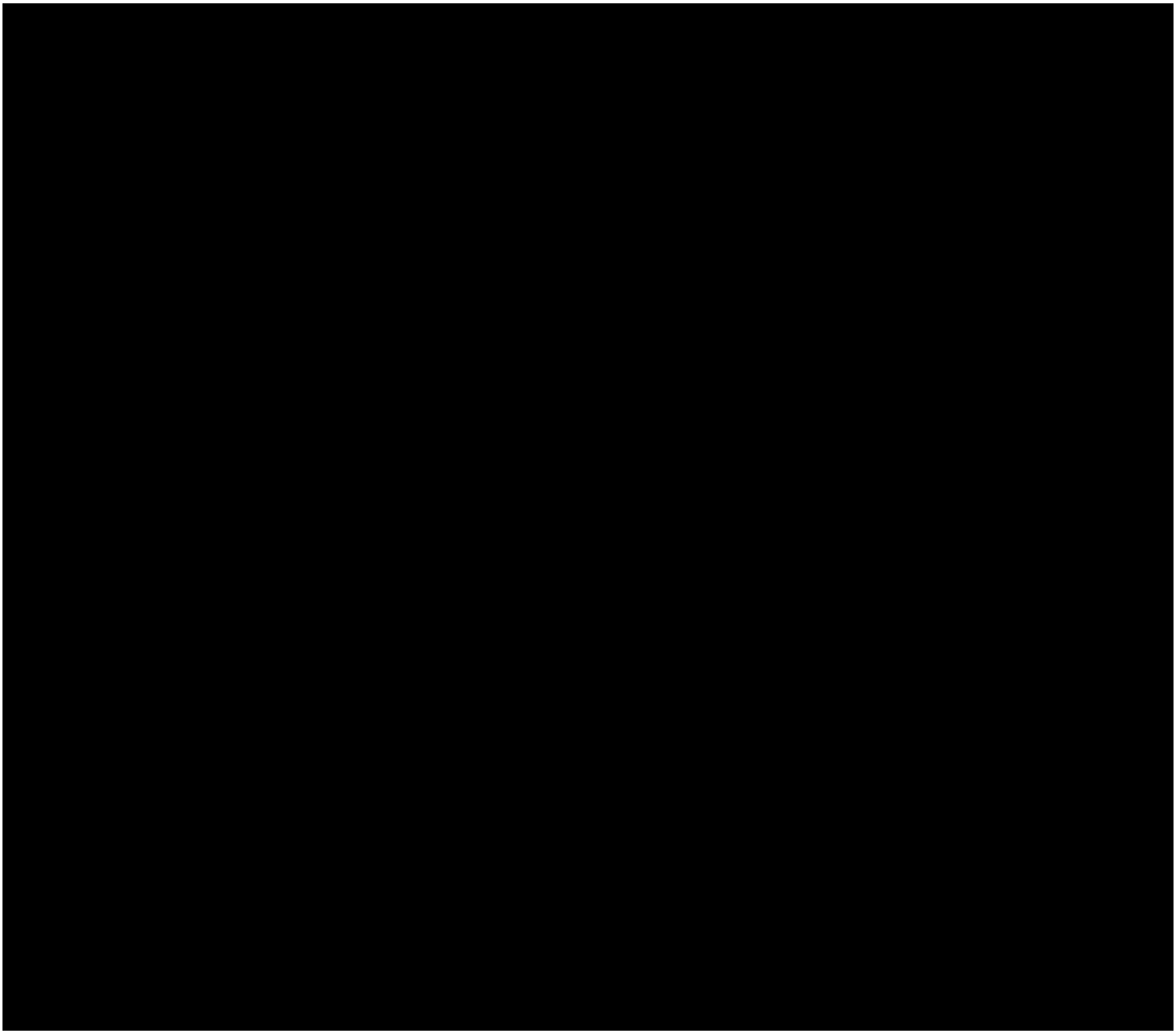
7.3.1.2 Grangemouth to Teesside

The long list of Full New Build options looked at how to achieve the objective of creating a UK hydrogen backbone that connects national strategic areas without repurposing existing NTS pipelines. Non-pipeline hydrogen transport options (shipping, road transport etc.) were also considered in the long list. [redacted]









- Non-pipeline solutions ranked low due to high technical complexity and high CAPEX and OPEX.
- Offshore options ranked low due to high CAPEX compared to onshore pipelines and scored low in future connections as they limit the ability for new customers to connect to the network outside of the national strategic areas.
- The options that ranked the highest were onshore pipelines that created a continuous network connecting the national strategic areas via the strategic connection points, as this best aligned with primary Project Union strategies and the customer needs cases identified through direct engagement.

7.3.2 Full New Build Shortlisted Options

7.3.2.1 Scotland

MCA were performed on the shortlisted strategic option Scotland - New Build F to determine the least constrained path between the national strategic locations and the strategic connections points. However, during the development of the MCA process, an iteration was performed connecting only the National Strategic Areas at a Great Britain scale without any restrictions on whether the pipeline should be routed onshore, offshore or across estuaries. This therefore presented an option that was aligned to strategic Option Scotland - New Build E. As this option scored relatively well in the strategic options analysis, to support retention of optionality and to provide a second counterfactual to repurposing, this option was also costed and subjected to CBA assessment.

This provided two indicative route corridors to achieve the strategic option. At this stage of the project a decision was made to connect all the strategic locations to ensure both options met customer needs. This approach enabled the relative cost and technical feasibility for each option to be fairly evaluated in terms of meeting the same customer needs.

[redacted]

7.3.2.2 Grangemouth to Teesside

The multi criteria analysis (MCA) was performed on the shortlisted strategic option, GT - New Build G, to determine the least constrained path between the national strategic locations and the strategic connections points.

This provided an indicative route corridor to achieve the strategic option. This approach enabled the relative cost and technical feasibility for each option to be fairly evaluated in terms of meeting the same customer needs. [redacted]

7.4 Cost Benefit Analysis (CBA)

The cost benefit analysis was completed to assess the relative economic impact of each option versus the counterfactual.

- The constraints from the impact on the methane network capability when removing feeders from the network for repurposing were considered for the CBA.
- The costs of any identified reinforcements for the methane network, in order to facilitate removing feeders for repurposing, have been included in the CBA.
- Capital costs estimates were based on option route lengths – units costs developed and refined through an iterative process, costs based on length and repurpose and new pipelines.
- Emission savings were calculated based off customer hydrogen forecasts taken from the data surveys detailed in chapter 6.
- The counterfactual considered was a full new build option, for the hydrogen transmission network in the Scotland and Grangemouth to Teesside regions, which routes to all the strategic connection points in the region. Reports from the CCC and NIC provide evidence that suggests there is no scenario where a hydrogen network does not exist in some form to deliver net zero by 2050. Therefore, the assumption has been made that 'do nothing' is not an option and full new build will be used as the counterfactual.

- For the counterfactual, we did not consider others means of decarbonisation for example electrification. We have been told by some of our customers that this would not be a viable option.

[redacted]

7.4.1 Scotland

[redacted]

Due to the same demand side customer base being connected, and therefore showing the same emissions savings, the main differences in the cost benefit analysis are due to the amount of new and repurposed infrastructure in each of the options. The output of the CBA shows a clear benefit to consumers through repurposing existing infrastructure compared to building new infrastructure.

[redacted]

[redacted]

7.4.2 Grangemouth to Teesside

[redacted]

[redacted]

7.5 Conclusion

The appraisal of the shortlisted options considered a range of factors to ensure that decision-making is based on a broad understanding of the implications of National Gas' projects. It considered:

- Environmental (National and regional level biodiversity, landscape and historic constraints and physical aspects, for example flooding)
- Socio-economic factors
- Technical (complexity, delivery and construction issues, sustainability and network capability considerations)
- Capital and operational costs and overall cost benefit
- Program and the ability to meet customer connection timing and facilitate government decarbonisation targets

7.5.1 Scotland

[redacted] the two preferred options to be taken forward for further development are:

[redacted]

From a GB perspective, the capability reduction associated with repurposing these sections of the NTS for Hydrogen must be assessed against the value added by avoiding the environmental and cost impacts associated with new build options.

Both options achieve the project objectives of connecting the two industrial clusters in Scotland and provide the opportunity for hydrogen production and demand in Scotland to connect to the UK Hydrogen Backbone. Critically, both options provide a connection opportunity for anticipated

surplus hydrogen production in Scotland to be exported and be connected to geological storage sites to the south.
The Hybrid and New Build options will be developed in parallel during the early part of FEED. In this time further analysis will be conducted to determine the preferred option. Once a decision has been made FEED will be refined to just one option. This approach will minimise any impact on the project timeline.

7.5.2 Grangemouth to Teesside

Both options achieve the project objectives of connecting East Coast to Scotland to create a continuous backbone, enabling surplus production in Scotland to reach demand and storage in the East Coast region, while also incorporating the interconnector which offers the potential to support decarbonisation of the island of Ireland.

The Hybrid and New Build options will be developed in parallel during the early part of FEED. In this time further analysis will be conducted to determine the preferred option. Once a decision has been made FEED will be refined to just one option. This approach will minimise any impact on the project timeline.

8. Scope of Works

The following chapter includes how the scope has been formulated through strategy development work and highlights how delivering this phase of work will close evidence gaps that exist today. In addition, this chapter outlines the programme of work to be undertaken as part of this funding submission which incorporates FEED for the St. Fergus to Teesside region.

8.1 Aims and objectives for PU: St. Fergus to Teesside

PU: St. Fergus to Teesside will deliver FEED for the region over a 24-month period. It will identify a preferred routing option through comprehensive design, detailed costing and a land consenting assessment for the implementation of a hydrogen transmission connection in the region.

As part of **St. Fergus to Teesside FEED** developed work packages, we will:

- Investigate the preferred technical options for routing within the region, linking concentrated hydrogen production hubs with demand centres and storage sites.
- Deliver conceptual design for PU: St. Fergus to Teesside, together with a construction programme and cost estimates for subsequent phases for PU: St. Fergus to Teesside.
- Engage with customers and stakeholders across the hydrogen value chain, including directly connected customers, GDNs, and new and emerging hydrogen sectors, to understand market demand, and supply chain hydrogen readiness.
- Establish and implement the lands and consents strategy, refining St. Fergus to Teesside route options and enable project delivery within programme timelines, non-statutory consultation, including DCO and planning application pre-application support.
- Complete the required environmental surveys, and Formal Environment Assessment (FEA) proforma required to comply with environmental consents for St. Fergus to Teesside route corridor.
- Collect and assess robust asset integrity information to ensure pipeline readiness for hydrogen transportation and support optioneering of sections to be repurposed.

8.2 Formulation of Scope

Ofgem's guidance on the structure and content of a Re-opener application is reflective of a more traditional investment decision on methane network assets. As part of building a compelling needs case, this entails a systematic approach to options identification, assessment, and selection. However, the funding proposed in this submission covers necessary preparatory work that is much earlier in the lifecycle of project development than might usually be the case and is centred on building the evidence base that will enable more informed decision making in future phases.

We have drawn upon a range of top-down and bottom-up approaches, using a combination of internally developed evidence, externally supported evidence, and stakeholder engagement to develop a scope of works characterised in Figure 34 – Approach to Needs Case and Scope Development. Work packages are separate with interdependencies, which have been identified and agreed across all work packages, to deliver achieved outcomes. The remainder of this chapter

details the approach and outcomes of the internally developed scope and stakeholder engagement. The Externally Supported evidence can be found in 5.2 Externally Supported Evidence.

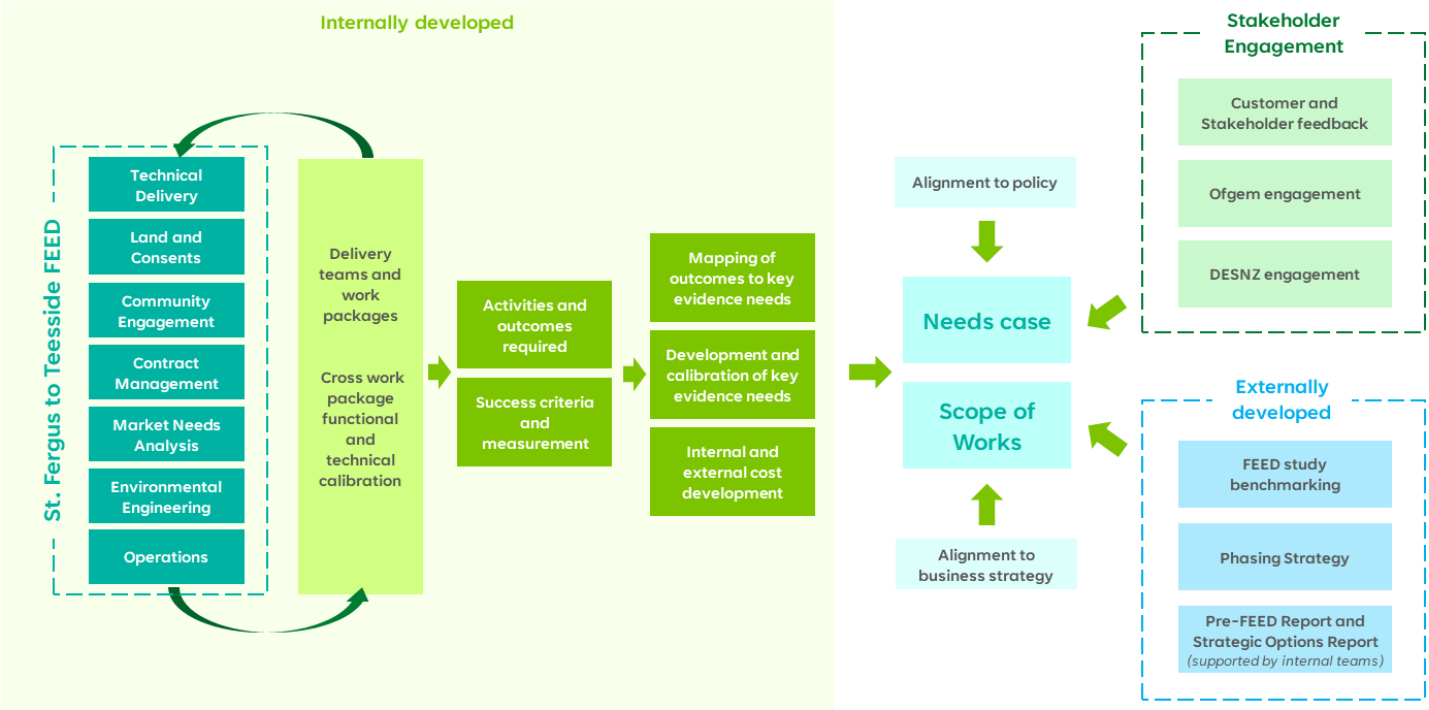


Figure 34 – Approach to Needs Case and Scope Development

The centrepiece to the internally developed evidence is the identification of key evidence gaps, and how outcomes and activities delivered through this phase of work will address them. Given the breadth of evidence needed to support future policy decisions and support the shaping of a hydrogen economy, we have carried out pre-engagement with both DESNZ and Ofgem to support the identification of evidence gaps and develop the scope of works required for this phase.

At the same time, a key objective of this phase is to ensure information and evidence sufficiency to enable moving the project into subsequent phases, subject to future funding requirements. The activities and outcomes required to support this have been assessed on a bottom-up basis by our internal project delivery teams, which reflect breadth of functional and technical specialism across the organisation. Teams are individually responsible for the development and delivery of work package scopes. Each work package has formulated a set of critical outcomes required to support the delivery of this phase of work and to enable subsequent phases of project development. Careful cross calibration of individual work package scopes has been undertaken to ensure alignment (particularly where work package input requirements straddle functional teams), drive internal efficiency and to eliminate duplication of activity. [redacted]

This approach enables mapping and calibration of planned bottom-up activities to a top-down assessment of future evidence need. This in turn enables the identification of appropriate criteria on which to assess the ultimate success of the project.

A supporting programme of work undertaken through Network Innovation Competition, Network Innovation Allowance (NIA) and Strategic Innovation Fund (SIF) provide technical information

regarding the transition and evidence to enable the repurposing of assets. [redacted]

8.2.1 St Fergus to Teesside work packages, outcomes, and success criteria

Over a 24-month period the programme will deliver FEED for the St. Fergus to Teesside region of Project Union. Successful completion of this will involve delivering the work outlined within the FEED work packages explored below. This section outlines the scope of the seven work packages identified, including the specific outcomes, and associated assessment criteria for each. The seven relevant work packages include: Technical Delivery, Land and Consents, Community Engagement, Contract Management, Market Needs Analysis, Environmental Engineering, and Operations. As detailed above, there are dependencies within each of these work packages, and will require coordination and collaboration. [redacted] At the same time, a key objective of this phase is to ensure information and evidence sufficiency to enable moving the project into subsequent phases, subject to future funding requirements. The activities and outcomes required to support this have been assessed on a bottom-up basis by our internal project delivery teams, which reflect breadth of functional and technical specialism across the organisation. Teams are individually responsible for the development and delivery of work package scopes. Each work package has formulated a set of critical outcomes required to support the delivery of this phase of work and to enable subsequent phases of project development. Careful cross calibration of individual work package scopes has been undertaken to ensure alignment (particularly where work package input requirements straddle functional teams), drive internal efficiency and to eliminate duplication of activity. [redacted]

Technical Delivery

The Technical Delivery work package will have overall accountability for the delivery of the technical elements of FEED. It will appoint the primary FEED contractor and work closely with it, co-ordinating work alongside specialist internal teams as appropriate. Technical studies will be undertaken to develop engineering designs, commence associated consenting activities, develop cost estimates and formulate delivery plans suitable for progression to the Engineering, Procurement and Construction (EPC) phase.

There is significant multi-way interaction and interdependency between the Technical Delivery work package, tasks undertaken by the FEED contractor and tasks undertaken by specialist internal NG Teams.

A scope has been developed to take a new build option forward into FEED in parallel to a repurposed option. It is proposed to progress FEED on both preferred options (see Chapter 7.5 Conclusion) until such time as the re-purposing can be definitively confirmed. At this point development of the new build approach would stop. Alternatively, any showstoppers to repurposing would lead to the progression of the new build option. This approach increases the overall funding request, however, minimises any impact on the project timeline should the repurposing option be ruled out. It is

believed that this is both appropriate and proportional when weighed against the benefits of a nationally significant project of this magnitude.

The table below lists key deliverables for the overall Technical FEED package. For key deliverables where primary responsibility for undertaking specific tasks sits within other NG specialist work packages but successful delivery of those tasks requires significant contribution from the Technical Delivery Work package (typically the FEED contractor) these are highlighted with an '*'. Only support required for this work package in relation to this submission has a funding request, other work packages that fall under PU: Essential Enabling Activities which were requested as part of the PU: East Coast Re-opener are referred to below, but no cost is associated as part of this submission. For scope details of these PU: Essential Enabling Activities please refer to the separate PU: East Coast Re-opener[95].

Key Outcomes	Success criteria
Delivery of FEED Studies including conceptual design, engineering assurance, environmental & ecological studies, and operational readiness information.	• Conceptual design for PU: St. Fergus to Teesside compliant with all relevant policies, standards, legislation etc. • Inform cost estimate for construction works • Support development of Construction Programme(s) • Agreed delivery strategy • Pipeline routings assessed using MCA to facilitate routing studies

Key Deliverables

- Conceptual design for PU: St. Fergus to Teesside; to include:
  - Provide Level 2 Routing Study to the requirements of IGEM/TD/1
  - Back-check and develop the pipeline route selection; to include MCA to choose optimal pipe routes for new hydrogen pipelines identifying segments suitable for the purpose and an assessment of the required mitigations and costs – **see separate Technical Development Scope*
  - Determine the layout of the hydrogen network pipeline connecting producers to AGIs and end users
  - Flow Assurance Modelling including Steady State and Transient Flow assessment – **see separate Network Modelling Scope*
  - Production of shapefiles for the pipelines (pipeline centre, working width, compounds, drainage, access and boundary information – used to transfer information between all parties Client, Designer, Land Agent etc).
  - Undertake Ground Surveys and Ground investigation (GI) as necessary (e.g. special crossings)
  - Environmental Surveys and reporting to inform route alignment and mitigation measures – **see separate Land and Consents and Environmental Engineering Scopes*
  - Engage with Stakeholders and undertake Statutory Consultation – **see separate Land and Consents scope*

[95] PU: East Coast NZASP Re-opener, April 2023

- Mechanical Design (including Operational, Health, Safety, Environmental and Sustainability requirements)
- Civil Design, including construction logistics and Temporary Works Designs for construction of pipeline and special crossings
- Electrical and Instrumentation Design
- Cathodic Protection Design
- Provide easement arrangements and land consenting
- Repurposing assessment in accordance with the requirements of TR/9, TR/10 and other relevant specifications
- Development of repurposed pipeline Operational, Health, Safety, Environmental requirements
- Formal process safety assessment

- Development of improved project Cost and Risk forecasts for delivery phase – **see separate Construction Scope*
- Delivery Programme(s)
- Delivery Strategy

Table 17 – Technical Delivery Key Outcomes, Success Criteria and Deliverables

Land and Consents

The Land and Consents work package will develop and progress the land and consents strategy and begin to develop the associated applications and acquisition of land rights specific to the selected route option for PU: St. Fergus to Teesside to maintain progress and enable project delivery within programme timescales. It will commence works associated with securing the consents and land rights for the selected options via the use of our existing land rights, permitted development rights, planning applications, DCOs, new easements, or Compulsory Purchase Orders (CPOs). The work package includes the associated surveys, engagement and reporting associated with obtaining the required land rights and consents. The aim is to achieve the outcomes below, however given the scale of the project and the lengthy timescales and challenges associated with the DCO process, this may not be possible during the FEED stage. This work package will work closely with the Community Engagement and Environmental Engineering work package.

With the St. Fergus to Teesside routing crossing both the English and Scottish border, a split lands and consenting strategy will need to apply as Section 20 of the Planning Act 2008 does not extend to Scotland and the English and Scottish components of the project will need to be consented and land right sought separately according to the planning regime in each country.

Outcome	Success criteria
Secure all necessary legal rights on / over land	• Compliant with chosen planning regime and statutory deadlines (for both Scottish and English applications) • Support of accompanying work packages • Dependent on preferred route option being identified through technical delivery work package, review of existing rights. Begin process of securing land/rights

	and access to land by agreement or through compulsory purchase powers where necessary and available
Survey access	• Obtain land access in connection with chosen planning regime requirements as well as facilitate land access for pipeline inspections
Land Referencing and statutory DCO / CPO documentation	• Completion of land referencing and land interest questionnaires • Preparation of DCO / CPO land plans and documentation
Develop Consultation Strategy and begin non statutory consultation with core stakeholders on Strategic Options and Route Corridors	• High level of engagement and sharing of information and views on proposed options and route corridors
Completion of Route Corridor Study and Preliminary Route Report (taking account of stakeholder views and identifying preferred corridors where possible) Updated Land & Consents Strategy for preferred option	• High quality route corridor report which has considered all options which will form the basis of public consultation and further stakeholder engagement
EIA Screening and Scoping in accordance with relevant planning regime	• Clear screening and scoping opinion to determine consenting and survey requirements
Environmental Surveys and Reporting (Non DCO) Preliminary Environmental Information Report (PEIR) (For DCOs)	• All necessary surveys undertaken and reported to inform route alignment and mitigation measures
Production of Statutory Consultation Documents / PEIRs for DCOs / EIA for planning application	• Completion of PEIR for DCO and supporting EIA / environmental reports and information for TCPA pre-application consultation
Consultation and Engagement - Planning Performance Agreements with Local Authorities and Discretionary Advice Service with Statutory Bodies	• Quality and timely advice which informs the development of the route alignment, surveys, consultation, and consents application
Quality Land & Consents Strategy and advice throughout application process. DCO, CPO Drafting	• DCO Scheme set up for Application Acceptance Non DCO set up for successful planning application and CPO

Key Deliverables

• Land Referencing and commence preparation of statutory DCO / CPO documentation • Survey access • Consultation and Engagement Strategy • Route Corridor Study and Preliminary Route Report • Updated Land and Consents Strategy • EIA Screening and Scoping Reports and response • Environmental Surveys and Reporting • Preliminary Environmental Information Report / EIA

Table 18 - Lands and Consents Key Outcomes, Success Criteria and Deliverables

Community Engagement

The Community Engagement work package will deliver non-statutory consultation and begin to develop the statutory consultation approach to support lands and consenting activities for PU: St. Fergus to Teesside. This work package will develop a considered stakeholder engagement strategy including customer interaction and public consultation as part of the consents process to enable PU: St. Fergus to Teesside. It will gather insights into the sentiment of various stakeholders including policymakers and the general public.

Outcome	Success criteria
Responsible for engagement delivery, sentiment analysis, media monitoring and interaction with existing and future customers to develop a Communication Strategy. Broader awareness and understanding of PU: St. Fergus to Teesside plans, impact on existing infrastructure, potential issues, interactions, and challenges to be considered and managed.	• Gain and share a clearer understanding of hydrogen perceptions at a local, national, and international level to identify key focus for communications strategy • Stakeholder mapping for PU: St. Fergus to Teesside, identification of interested (or disengaged parties) and opportunities to build relationships and understanding of the project and benefits to the future energy landscape
Preparation for (non-statutory) public consultation and planned engagement with stakeholders to inform and shape the strategy and communications programme for PU: St. Fergus to Teesside; and to develop and establish phasing plans in accordance with gathered insights. Considered consultation engagement plan on preferred route corridor to ensure statutory consultation is undertaken in a timely and effective way, and thus avoid delays in the project timeline. Consultation strategy agreed with local planning authorities.	• Agreed Statement of Community Consultation (SoCC) / Consultation Strategy • Collation of information about PU: St. Fergus to Teesside synthesised into an accessible format for a non-expert audience • Production of engagement materials including digital resources (website, apps), information leaflets, engagement events, consultation resources • Demonstrate engagement plans for public consultation • Understand and communicate (through collaboration with Land & Consents work package) route options that stakeholders can contribute to and shape • Engagement with all directly connected customers and relevant stakeholders to inform on the progress of the project and to feed into ongoing phasing route options

Systematic, evidence-based review and reporting through the process, including for Consultation purposes: this to include clear consultation feedback report.	• An overview of the impact of engagement activity, changes, and recommendations on the potential development of PU: St. Fergus to Teesside

Key Deliverables
• Consultation Engagement Strategy (agreed with Local Planning Authorities (LPAs) • Public consultation on preferred corridor and preliminary route (non-statutory consultation) • Consultation Feedback Report (non-statutory consultation) • Statement of Community Consultation / Consultation Strategy

Table 19 - Community Engagement Key Outcomes, Success Criteria and Deliverables

Contract Management

The Contract Management work package will support the Supply Chain work package in developing the contracting and procurement model and strategy by providing St. Fergus to Teesside specific procurement requirements and market engagement. These activities will ensure the successful appointment of partners to support PU: St. Fergus to Teesside (cost, time, and quality). Once contracts have been awarded this work package will be pivotal in managing the live contracts to ensure they deliver on time and budget.

Key Outcomes	Success criteria
Commercial and quantity surveyor (QS) Support for live contract management of FEED and other enablement works	• QS support for PU: St. Fergus to Teesside FEED section

Key Deliverables
• FEED contract awarded for PU: St. Fergus to Teesside

Table 20 - Contract Management Key Outcomes, Success Criteria and Deliverables

Market Needs Analysis

The Market Needs Analysis work package will support the next phase of work by identifying customer requirements of a hydrogen transmission network within the St. Fergus to Teesside region. This work package will continue to engage with customers and stakeholders, refining data on hydrogen demand, production, and storage, building the evidence base for the market and further investment incentive in the area. In addition, it will review existing and potential connection arrangements, and secure greater customer certainty and awareness of PU: St. Fergus to Teesside developments by building advocacy more across broader stakeholders and in new policy developments.

Key Outcomes	Success criteria
Increased understanding of direct customer needs and inform stakeholder landscape.	• Consumer research confirms increased advocacy for hydrogen • Refined market data assumptions • Non-binding customer commitments for connections to PU: St. Fergus to Teesside • Memorandum of Understanding (MoU) developed • Favourable strategic direction from policy makers • Campaign analytics
Build relationships and collaborate with new industry and new sector GDNs.	• New relationships developed across potential sectors • Refined engagement content shared with existing customers and potential new industry and sectors
Through understanding opportunities for a hydrogen market identify potential new connections.	• Holistic view of how Project Union / the NTS can support regional decarbonisation plans • Review of existing contracts to understand customer needs now and in the future

Key Deliverables
• Refined market data assumptions • Industry and sector roundtables insights

Table 21 - Market Needs Analysis Key Outcomes, Success Criteria and Deliverables

Environmental Engineering

The Environmental Engineering work package will manage the application of National Gas management procedure T/PM/ENV/20 and application of FEAs during PU: St. Fergus to Teesside FEED and project delivery phases (FEA applies throughout the project until close). ENV/20 is designed to work in tandem with the Lands and Consents work package. Environmental Engineering will provide Subject Matter Expert (SME) support to ensure that a bespoke and detailed FEA is produced during FEED, the complexity of the project means that critical environmental consents will have to be carefully managed and the required environmental surveys are carried out in time.

Key Outcomes	Success criteria
Deliver FEA for FEED through collaboration with the Lands and Consents work package, supporting planning and consenting applications and informing design options for subsequent design phases.	• Required environmental support for surveys identified and completed for FEED • FEA proforma populated and managed to completion for FEED • Liaise with local environmental regulator to identify specific environmental requirements for project • Support from environmental SME for PU: St. Fergus to Teesside design requirements

Key Deliverables

• FEA proforma populated and managed to completion for PU: St. Fergus to Teesside FEED

Table 22 - Environmental Engineering Key Outcomes, Success Criteria and Deliverables

Operations

The Operations work package is a new work package for this Re-opener. During FEED, this work package will deliver ILI runs using new technologies to collect robust asset integrity information to inform technical analysis of PU: St. Fergus to Teesside pipeline routing options. The enhanced ILI capability will enable us to make a much more accurate assessment of a pipe's readiness for transporting hydrogen and support narrowing down pipeline options for repurposing, as well as ensure maintainability and operability is factored into early design.

Key Outcomes	Success criteria
Robust asset information to enable assessment of hydrogen capability of the network assets	• Novel in-line inspection tools on chosen feeders successfully deployed; completing an inspection to collect Hydrogen related integrity data

Key Deliverables
• Successful delivery of ILI runs to validate condition of pipelines for repurposing • Successful delivery of additional asset inspection(s) identified as necessary following completion of ILI runs or desktop studies

Table 23 - Operations Key Outcomes, Success Criteria and Deliverables

9. Cost Information

This chapter outlines our approach for developing project costs and provides headline project costs by work package. We describe the methodology adopted for the treatment of real price effects and general inflation, aligned to RIIO-2 framework principles, and how risk and contingency has been reflected in our cost plan. We demonstrate how minimum cost has been assured to support value for money for gas network users and consumers.

9.1 Project Costs

A high-level summary of proposed project costs is shown in Table 24.

Price Base	2021/22	2022/23	2023/24	2024/25	2025/26	Total
[redacted]						
2018/19	[redacted]					**98.497**

Table 24 - Proposed Project Cost - Costs are shown inclusive of inflation adjustment and added contingency

Table 25 summarises the steps to convert raw bottom-up project costings into a final 2018/19 price-based position.

Internal/External Summary by Price base	Internal (£m)	External (£m)	Total Cost (£m)
Nominal costs before contingency (2023/24 prices)	[redacted]		
Conversion to 2018/19 prices			
Contingency (2018/19 prices)			
Total costs including contingency (2018/19 prices)	[redacted]		**98.497**

Table 25 - Steps from nominal cost to total proposed costs including contingency

[redacted]

9.1.1 Cost plan build

Our approach to project cost development was a complex and detailed exercise, as characterised in Figure 35 below. However, the overarching aim was to ensure full integration of scope build, evidence need mapping, activity costings, and transparency of assumptions throughout. The functional specification used for the purpose of this submission, methodological steps, and the key assumptions can be found inAt the same time, a key objective of this phase is to ensure information and evidence sufficiency to enable moving the project into subsequent phases, subject to future funding requirements. The activities and outcomes required to support this have been assessed on a bottom-up basis by our internal project delivery teams, which reflect breadth of functional and technical specialism across the organisation. Teams are individually responsible for the development and delivery of work package scopes. Each work package has formulated a set of critical outcomes required to support the delivery of this phase of work and to enable subsequent phases of project development. Careful cross calibration of individual work package scopes has been undertaken to ensure alignment (particularly where work package input requirements straddle functional teams), drive internal efficiency and to eliminate duplication of activity. [redacted]

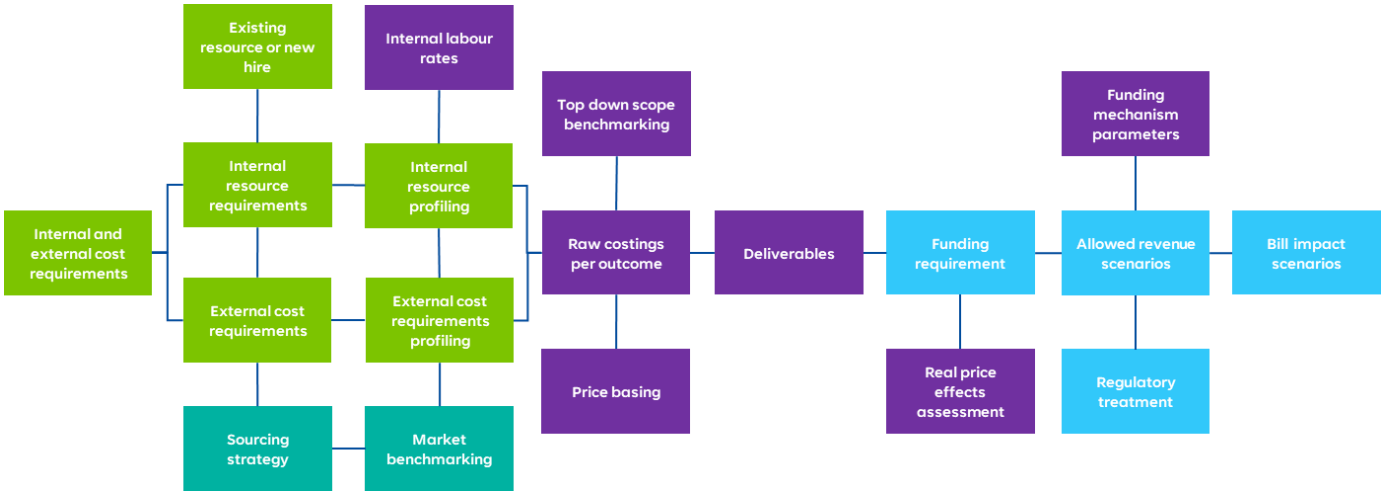


Figure *35* - Approach to Project Cost Development

Total costs for this submission carry an [redacted] internal resource cost to external cost weighting. Internal resource costs have been estimated based on anticipated resource utilisation by staff grade, using system labour rates, and cost factors taken from in-house cost data. External costs have been established through internal project comparison with projects of similar size and scope and external benchmarking carried out by independent third parties. The current level of cost confidence [redacted] for technical FEED is consistent with other projects at a similar stage and reflects the inherent uncertainties due to further engineering work required to finalise the scope of works; detailed design; and the completion of tendering processes, engineering, and procurement. These external costs reflect an increase compared to the Feasibility phase as the nature of FEED and enabling activities required to deliver specified outcomes are more cost intensive due to technical externally procured services.

There are many potential sources of over-run for a project of this type, such as schedule delays, labour disputes, supplier problems, etc. There will be many such risks on the project risk register,

many of which will not occur. However, as they all have a finite chance of happening, some will occur and have a cost impact, others might require mitigation to be put in place, at a cost, to ensure that either they do not occur, or they can be dealt with.

Moreover, not all assumptions made will turn out to be valid. Some will have been based on early available information, but there is no allowance in the base estimate for wrong assumptions. There may also be considerable uncertainty in the estimate because of work yet to be performed or finalised, e.g., flow assurance. Any one of these could have a significant impact on the cost estimate. Details on the assessment for the proposed contingency has been addressed in section 9.4 Allowing for Project Risk.

At the same time, a key objective of this submission is to ensure information and evidence sufficiency to enable moving the project into subsequent phases, subject to future funding requirements. The activities and outcomes required to support this have been assessed on a bottom-up basis by our internal project delivery teams, which reflect breadth of functional and technical expertise across the organisation. Teams are individually responsible for the development and delivery of work package scopes. Each work package has formulated a set of critical outcomes required to support the delivery of this phase of work and to enable subsequent phases of project development. Careful cross calibration of individual work package scopes has been undertaken to ensure alignment (particularly where work package input requirements straddle functional teams), drive internal efficiency and to eliminate duplication of activity. A full breakdown of the costs for each work package can be found inAt the same time, a key objective of this phase is to ensure information and evidence sufficiency to enable moving the project into subsequent phases, subject to future funding requirements. The activities and outcomes required to support this have been assessed on a bottom-up basis by our internal project delivery teams, which reflect breadth of functional and technical specialism across the organisation. Teams are individually responsible for the development and delivery of work package scopes. Each work package has formulated a set of critical outcomes required to support the delivery of this phase of work and to enable subsequent phases of project development. Careful cross calibration of individual work package scopes has been undertaken to ensure alignment (particularly where work package input requirements straddle functional teams), drive internal efficiency and to eliminate duplication of activity. [redacted]

Note that Project Union: Essential Enabling Activities, work critical to ensuring a fully operational and accessible hydrogen transmission network was submitted within the Project Union: East Coast reopener. It is assumed that this activity is funded and occurs, and therefore not included in this submission. However, if funding for Project Union: Essential Enabling Activities is not granted through the PU: East Coast NZASP Re-opener, another funding mechanism will need to be explored (e.g., an additional, separate Re-opener submission) as the FEED phase cannot be undertaken without the support of these activities.

9.1.1.1 St. Fergus to Teesside FEED cost composition and justification for funding

Work package	Internal	External	Total
Technical Delivery	[redacted]		

The preferred strategy for Project Union is based around repurposing existing NTS pipeline as much as possible due to the significant environmental, cost and time benefits this approach provides (see Project Union: Feasibility Phase Re-opener for more details).

To deliver Project Union on a timeline that supports the delivery of Government decarbonisation targets, it is necessary to progress the early stages of project development in parallel to completing validation of the evidence base for some of the technical considerations around repurposing. The benefits of the repurposing approach are so significant that this approach is considered appropriate however, there is still a risk that repurposing may ultimately not be possible due to technical reasons.

This may be due to, for example:

- The inability to release pipelines from the NTS (e.g., the results of more comprehensive network analysis identify an unacceptable impact on NTS operability or risk levels)
- More detailed condition assessment identifies technical defects that preclude repurposing for hydrogen use
- Other findings from ongoing innovation projects preclude repurposing NTS pipelines for hydrogen use

Every effort has been made during and prior to the Feasibility phase to identify and assess the primary factors which may lead to an adverse repurposing decision. Based on the work conducted to date there is a high level of confidence that repurposing is technically possible. However, there remains a risk that new information may come to light.

The likelihood of this risk is considered to be very low, but the consequences of this risk materialising could be significant. The most notable consequence would be a major impact on the project timeline and thus the ability to facilitate decarbonisation objectives in the St. Fergus to Teesside region by the current target dates.

To mitigate this risk, initial development work has started to assess a full new build option as part of the pre-FEED. This option would achieve the same objectives of connecting customers to a core hydrogen backbone, but by constructing an entirely new pipeline network.

A scope has been developed to take this new build option forward into FEED in parallel to a repurposed option. It is proposed to progress FEED on both options until such time as the re-purposing can be definitively confirmed. At this point development of the new build approach would stop. This approach increases the overall funding request, however, minimises any impact on the project timeline should the repurposing option be ruled out. It is believed that this is both appropriate and proportional when weighed against the benefits of a nationally significant project of this magnitude.

This work package will deliver FEED studies for the St. Fergus to Teesside region, requiring a FEED Project Manager to lead the process and coordination of inputs from other work packages. This team will have overall accountability for developing the conceptual design for PU: St. Fergus to Teesside, as well as the engineering designs and environment and ecological studies to support. Construction expertise are needed to inform construction planning and support the development of

a construction programme as well as a delivery strategy for the subsequent phases of PU: St. Fergus to Teesside.

Technical FEED:
An Engineering Consultancy will provide rigour and technical expertise for the development of the conceptual design of PU: St. Fergus to Teesside for repurposed and potential new build pipeline sections and compression required. These activities will include engineering designs compliant with relevant policies, environmental and ecological studies to support consenting and inform construction planning, cost estimate for construction works, construction programme(s) and agreed delivery strategy. The cost estimate for this work has been informed by internal benchmarking of FEED projects as well as market feedback from external Engineering Consultancies to gain understanding of what they would define as scope requirements and initial estimates of the costs for FEED delivery. We have then assessed this scope, identifying and removing some of the components where we are planning on delivering this work internally.

Continued bespoke multicriteria analysis is to be carried out using Geographical Information System (GIS) data obtained by National Gas. Results of which would provide a weighted list of potential routes and sites to inform and validate final route selection. GIS data is then to be visualised within online Web Application. Provision of a specialist GIS system is required to undertake this analysis, for this submission cost estimates have been based on budget proposals from external consultants.

Compression:
One of the key tasks to be undertaken early on during FEED is to confirm any need for compression and produce high level compression requirements. This will enable FEED to be undertaken on any required compression assets, in parallel to FEED on the pipework sections. This will ensure that, if required, compression can be constructed on the necessary timescales to not delay network operation.

Initial Flow Assurance conducted on an indicative short listed Strategic Option has identified a need for compression when considering flows on a 'static' basis i.e., steady state flow conditions. The flow assurance looked at 4 stages of development of the network and the compression requirements for each of these stages. St. Fergus to Teesside was included in stage 2 of network development which looked at the need for compression when St Fergus to Teesside and North West are added onto the East Coast network. In stage 2 compression is needed to boost the pressure of the hydrogen moving between the Teesside and Scotland sections. The exact location and size of the compressors will be assessed in more detail during FEED.

The need for compression will also be driven by variable flows on the network as expected from the operation of, for example, connected storage sites and power generators. These variable flow rates can cause rapid localised depletion of linepack and reduce network pressures to unacceptable levels. This effect will be more pronounced in a hydrogen network compared to a natural gas network due to the lower energy density of hydrogen compared to methane. For the same energy flow rate approximately three times the volumetric flow of hydrogen will be required (compared to natural gas). Similarly, linepack in a hydrogen network will only contain approximately one third the energy by volume when compared to a natural gas network. To effectively and safely manage a hydrogen network there is a key requirement to have access to tools that can provide operational flexibility to maintain network pressures. This requirement can only be fully evaluated by

undertaking transient flow analysis (i.e. assessing the impact of changing flows over time).

Once a preferred network design is produced and more detail on likely customer operating requirements is understood, transient flow analysis will be conducted across a range of scenarios. Any requirement for compression can then be carefully quantified, identifying both the operating range and power levels required and the preferred network location. These parameters will form the basic requirements for the initiation of compression FEED.

Work package	Internal	External	Total
Land and Consents	[redacted]		

The Land and Consents work package is essential to project delivery. Expert land and consents resource is required in the form of a DCO project manager to oversee the land, consents, environmental and legal work as well as significant external resource to undertake the associated lands and environmental work required to set applications up for success.

External services are requested to help progress the works associated with developing the application/s for consent and to begin the process of securing the associated land rights to deliver the project, at this stage this is assumed to be via a DCO. This will require significant external resource to complete for example optioneering and routing work, land referencing, developing the land and consents strategy, engaging with stakeholders, commencing environmental surveys, and the preparation of associated reports, reviewing existing land rights, securing land access for surveys, securing land rights for the project and associated legal input and review. Estimated costs include non-statutory consultation and preparation for a DCO submission, outlined above.

Cost estimates for this work have been developed by internal benchmarking against previous experience promoting DCO projects, National Grid linear projects, as well as market feedback from external consultancies to gain understanding of what they would define as scope requirements and initial estimates of the costs for lands and consents delivery within a 24-month scope. As the Feasibility phase has not selected a preferred option, the scope of works and cost for the full DCO submission has not been included.

A DCO submission, DCO examination, acceptance and post DCO approval activities including land acquisition are not part of the scope for this submission. We will seek additional funding through an appropriate mechanism, for example the Hydrogen Transport Business Model (HTBM) allocation process or a further NZASP Re-opener based on a single option.

Note that given the cross-border nature of the routing situated across Scottish and English borders, separate lands and consent strategies will apply, therefore costs are reflective to consider the separate legislations required.

Work package	Internal	External	Total
Community Engagement	[redacted]		

A dedicated team with communications experience and expertise will be required to devise a suitable communications and engagement strategy from the early stages of project planning. Identifying and engaging early with the many customers and stakeholders along proposed routes,

as well as developing clear messaging will be invaluable to project perception externally. Consultation engagement required for DCO will require substantial resource to deliver the various communication and collation of feedback, management of responses, and detailed report writing.

External services are requested to help deliver a clear communication strategy for public consultation required for a proposed DCO, which includes stakeholder mapping, development of strategy, messaging, consultation engagement planning and development of communication tools and materials for non-statutory and statutory consultation process delivery and reporting. Cost estimates are based on high level budget proposals from external communications agencies based on their previous experience on similar construction or infrastructure projects, as the Feasibility phase has not selected a preferred option, these costs could vary, this is captured in 9.4 allowing for project risk.

Work package	Internal	External	Total
Contract Management		[redacted]	

The Contract Management work package will work closely with the Supply chain work package, supporting the development of the contracting and procurement model, specifically informing key requirements for the St. Fergus to Teesside region.

Once contracts are awarded for PU: St. Fergus to Teesside our Quantity Surveyors (QS) will be pivotal in managing the live contracts to ensure they deliver on time and budget. Given the nature of FEED, and the level of uncertainty in its definition, having commercial counterparts is especially important. The core responsibility for these roles is supporting the project manager and team to report on contractual compliance, forecasting accuracy and review potential compensation events raised by the contractors. Behaviourally QS's can ensure collaboration is at the forefront of how we manage our contracts.

Work package	Internal	External	Total
Market Needs Analysis		[redacted]	

Specialist expertise is required to conduct intelligence activities and engage with a wider range of customers and stakeholders, in relation to hydrogen demand, storage and production. A greater depth of information is required from customers building on information gained in the Feasibility phase to support the conceptual design of the network and to input into the network modelling work package.

To build on existing work from the Feasibility phase, specifically building on the results of the Hydrogen Acceptability Study conducted by [redacted]. The study provided a high-level assessment of the potential technical barriers that could impact the feasibility of transitioning NTS directly connected sites to 100% hydrogen. Further work is required to fully assess potential barriers and develop a transition pathway for these sites, as part of the FEED phase external support is required to conduct consumer research and technical assessments to provide customers with more certainty and awareness.

Work package	Internal	External	Total
Environmental Engineering		[redacted]	

With the support from the existing Environmental Engineering team, an appointed external Environmental Coordinator will be responsible for delivery of FEA requirements and assessing related environmental constraints associated with the project as this role have been similarly required for the delivery of methane projects. They will support with inputs to surveys led and undertaken by the Lands and Consent work package. The FEA process outlines activities that will need to take place during PU: St. Fergus to Teesside FEED, which encompass environmental requirements for planning consents, environmental regulator engagement, identification of natural risks and sustainability opportunities.

Work package	Internal	External	Total
Operations	[redacted]		

The work carried by the Operations work package consists of technical exploration of assets with in-line inspection tools on chosen feeders is a critical activity to assess repurpose capability of our methane assets, rather than requiring new build. This will enable long term environmental, societal, and financial benefits, which ultimately enables Project Union to provide more value for money.

Current ILI data doesn't capture hydrogen required information, so specific technology to prove hydrogen capability is needed. Scope for these works includes the collection of integrity data and analysis of the collected integrity data to provide a technical summary of the pipeline sections readiness for repurposing to hydrogen. In addition, providing additional information to inform assumptions for other pipelines with similar properties. Delivery of this work is key to support the development of optimised routes and phasing for the sections of Project Union. The required external work also includes operational costs, pig cleaners, waste disposal and National Gas Services (NGS) support associated with the ILI runs.

Costs to undertake ILI run surveys were estimated based on costs provided by [redacted] for three hydrogen ILI runs we plan to complete; this was combined with additional operational costs provided by NGS which have been benchmarked against recent methane pipeline ILI runs (including assumptions to adjust to a hydrogen system).

9.2 Cost Efficiency

Due to the nature of many of the outcomes proposed in this phase, cost estimation has been challenging in many areas. Feasibility work conducted over the past 12 months has provided greater clarity on investment requirements.

To assure the efficient level of proposed costs, we have taken the following actions:

- **Optimisation of internal resource:** our cost plan is based on optimised utilisation of enduring internal resource. This has numerous advantages, not limited to growth and retention of hydrogen specific skills and capabilities, synergistic knowledge pooling between methane and hydrogen assets, protection of ongoing resilience and capability of the methane network and overall efficient delivery of RIIO-2 business plan commitments. Where resource requirements are transient or general, we look to the external labour market to support needs.

- **Cost risk sharing:** as described in chapter 11, we propose that any unspent allowances are returned to consumers in full and if an efficient overspend is necessary during the course of the project and exceeds the allotted risk pot, NGT should be fully protected from that overspend. We believe there should be a fair balance of risk sharing between consumers and NGT.
- **Benchmarks:** our submission includes several external costs, where possible, historical benchmarks from similar projects have been used.
    - Technical FEED; to develop this cost (i) internal benchmarking on FEED projects which includes comparison to Western Gas Network, (ii) market engagement to provide high level cost estimate.
    - Although we were provided with costs from external suppliers these were based on high-level proposed scopes and still require a formal tender process to fully understand the expected costs. Until this is possible a level of uncertainty remains around scope and further development is required to understand the implication on costs, we have therefore proposed a risk pot to progress the next phase of work which will provide further clarity. We have reflected this in more detail in our risk assessment which is explored in more detail in Section 9.4 Allowing for Project Risk.
- **Procurement efficiencies:** Where frameworks existing and when suitable to do so, we will be competitively tendering to ensure best value is achieved. We are developing our contracting strategy given the scale of the project to drive efficiency, secure reliable suppliers and drive market competition to drive costs down to the consumer.

9.3 Allowing for Inflation and Real Price Effects

Our cost plan has been prepared in a 2023/24 price base and wound back to a 2018/19 equivalent using the forecast inflation indices included in the Re-published RIIO-GT2 Price Control Financial Model (PCFM) by Ofgem in January 2024[96]. The inflation indices published in the PCFM cover actual published retail price index (RPI) and consumer price index including owner occupier housing cost (CPIH) data points up to [redacted]. This means that inflation indices for the 2023/24 financial year are predominantly based on forecasts. Accordingly, we recommend that price basing is revisited at the point of final determination to ensure that allowances are based on the most accurate and up to date inflation data.

Given that the cost plan has been produced in current prices, the weighting of costs to internal or external labour, and the 24-month time frame for this submission, we do not consider that any separate adjustment for real price effects (RPEs) is warranted, and that standard indexation of allowed revenues to general inflation would adequately cover any risk in this regard.

9.4 Allowing for Project Risk

A Monte Carlo analysis has been conducted to understand the risk associated for this phase of the project. It assesses risk by looking at the probability and impact. [redacted]

[96] RIIO-2 Annual Iteration Process 2023 for Transmission and Gas Distribution | Ofgem

The risk associated to PU: St. Fergus to Teesside has considered two main elements:

(i) FEED works – this element includes the risk relative to consultation and design. Risks include inaccurate estimation for compression requirements to be unveiled by design works, customers requirement changes that affect design, new information from innovation work, policy/ government changes, lands and consents assumptions, changes in distribution network plans, new information from flow assurance and methane resilience, new information from surveys and consultation, among others.

(ii) In Pipe Survey works – which includes the risk relative to the in-line inspections on chosen feeders to collect hydrogen related integrity data. Risks include inspection tool availability, inaccurate resources estimation, technical complexities, among others.

[redacted]

9.5 Contribution towards project

Ofgem's NZASP Re-opener Governance Document expects networks to consider a direct company contribution where a potential NZASP project is substantially innovation related, for example, it could also be eligible for funding under either the NIA and SIF.

RIIO-2 innovation funding mechanisms describe innovation projects as collaborative projects involving research, development and demonstration. In Ofgem's RIIO-2 NIA Guidance document it sets out the eligibility criteria for an Innovation project and emphasises the importance of demonstrating the originality of the innovation e.g., new technology, new equipment, new methodologies and novel practices. Similarly, Ofgem's SIF Guidance document highlights that: 'Projects must be innovative, novel and/or risky. Projects must generate new learning and entail a degree of risk, so that they would not otherwise be taken forward as business-as-usual activities.

One of the core deliverables of this phase of the project is the completion of FEED activities. This is a commonly used and well-defined process within our business and the wider Industry and cannot reasonably be considered to be an innovative methodology or approach, and therefore would not be eligible for funding under either the SIF or NIA. In addition, over the last few years, there has been significant developments in Hydrogen both in the UK and across the world and we have seen for example, the German government on the 5th of April, agreed a comprehensive financing mechanism for the country's future hydrogen network to be constructed by 2037 and it will extend over 9,700 km (6,000 miles)[97] and all of these developments have shaped industry intelligence and increased policy confidence in the importance of hydrogens future role. This has also allowed the UK Government to set a clear direction of travel with the first competitive allocation process to support funding for the early rounds of hydrogen network delivery set to take off this year. The scale of Hydrogen production and storage capacity planned in the coasts. The St. Fergus to Teesside region is significant and the creation of a Hydrogen Transmission network will allow for even further potential Hydrogen growth in the region. Given the clarity that we now have in Government's

[97] Reuters, (2024), German coalition agrees financing details of hydrogen network; https://www.reuters.com/business/energy/german-coalition-agrees-financing-details-hydrogen-network-2024-04-05/

ambition to have an operational Hydrogen Transport and Storage Business model by 2025, the level of uncertainty and risk required for an innovation project is considerably diminished.

By contrast, our FutureGrid project is substantially innovative, involving the construction of a test facility from decommissioned assets that is being used to carry out a wide range of hydrogen tests in an offline environment, to demonstrate its effect on our assets, as well as the operation of our network. Through innovative and rigorous testing, the FutureGrid project is allowing us to gain an understanding of how the gas network will need to be developed and operated, to deliver sufficient volumes of hydrogen to our customers, as well as help us better understand what impact transporting hydrogen has on the ongoing maintenance of pipelines and other components that make up the NTS. This innovation has supported our understanding of the costs for repurposing which we have applied to our FEED proposals.

It is equally important to recognise that we have made full financial contributions and, in some cases, additional contributions across all of the key phases of the Future Grid Phase 1, Deblending and Compression projects in excess of £6 million, given the substantially innovative nature of those projects. However, given the expected scale of the Project Union in comparison to similar activity within distribution networks, we do not think it is either appropriate for Ofgem to expect any further contributions from NGT given the stage of the project or feasible as this could immediately become cost prohibitive.

A FEED study is not itself a substantially innovative activity with innovative deliverables, but the output of the FEED stage will be crucial to the subsequent stages of the project, moving the project from conceptual design into delivery while providing important evidence to support the Government's activity on net zero, driving forward delivery of early, critical hydrogen network infrastructure to directly support achieving the Government's net zero ambitions.

We recognise the importance of driving value for consumers given the scale of investment that will be needed, and our aim is that throughout the programme, we will continue to strive for innovative and efficient delivery. We also note that for the delivery of critical net zero projects of a similar scope and size in Electricity Transmission, there is no precedent of network companies being required to provide a contribution, especially under the Accelerated Strategic Transmission Investment (ASTI) framework, which has been introduced for electricity transmission and in some cases, there is no requirement for an initial or final needs case for developmental / pre-construction activities thus enabling a more rapid completion of critical development activities without mandatory requirements for contributions that could become prohibitive to realising Governments ambition.

Finally, the funding of the build phase for this project will be subject to a competitive allocation process and given the expected scale and materiality across the reopener pipeline for Project Union, it is unreasonable to expect shareholders to assume such a level of financial exposure when significant uncertainty remains about the outcome of initial allocation rounds and the future business model and it will also be unfair to pre-empt or speculate the outcome of that process by making direct financial contributions at this stage.

Noting some of the points above, we are proposing **no direct company contribution as we take the view that the development of hydrogen infrastructure is equally crucial to Government's net zero**

ambition and Ofgem's net zero mandate set out in the Energy Act 2023 and we are committed to helping to deliver on this ambition and instead we make the following proposals, recognising the importance of shielding bill payers from short term cost impacts;

- As set out in section 11.3, we are proposing **a TOTEX funding approach with a Regulatory Asset Value (RAV) capitalisation rate similar to regimes established for Uncertainty Mechanisms** under the RIIO-2 framework. This will facilitate intergenerational cost allocation, allowing for substantial parts of the cost to be captured in any future fair value transfer when considering asset repurposing.

- We are already proving that the repurposing of gas transmission assets is possible, given the progress from our FutureGrid project, which is now transporting 100% hydrogen and we believe that this provides important evidence needed to circumvent significant decommissioning costs for methane consumers and therefore we propose that **project costs for this FEED application, needed to move the project from concept to delivery should be covered in full**.

- We propose that all of the project costs should form for part of the transfer cost in the future.

- Although the TOTEX Incentive Mechanism [TIM] remains an effective tool for network companies to improve efficiency in delivery, sharing these benefits with consumers, but we believe that it may be more appropriate for the **project costs to be excluded from totex incentivisation at this stage**, offering additional protection to consumers.

- We also propose that **any underspend at the end of the project is fully returned** to network customers much like the Net Zero Use it or lose it allowance but we should be protected for any overspend.

10. Project Delivery and Monitoring

For Project Union, we intend to follow a broadly similar approach to the existing Gas Network Development Process known as ND500, adapting where necessary to accommodate the specific challenges presented by the 'first of a kind' nature of the transition process to hydrogen.

As the project progresses into the FEED phase, Project Union will be governed through the ND500 stage gate process. An overview of this process can be seen in Figure 36. The FEED phase will cover stage 4.2 and critical activities identified from stage 4.3 of the ND500 process which are anticipated to require a greater amount of time to complete for activities related to hydrogen transmission due to the novel nature of the work.

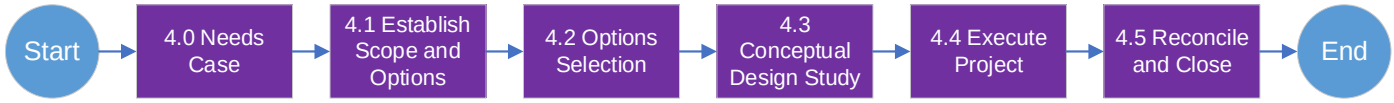


Figure 36 – ND500 Process

10.1 FEED Phase Project Governance

A governance structure to support the Project Union FEED Phase has been established in Figure 37.

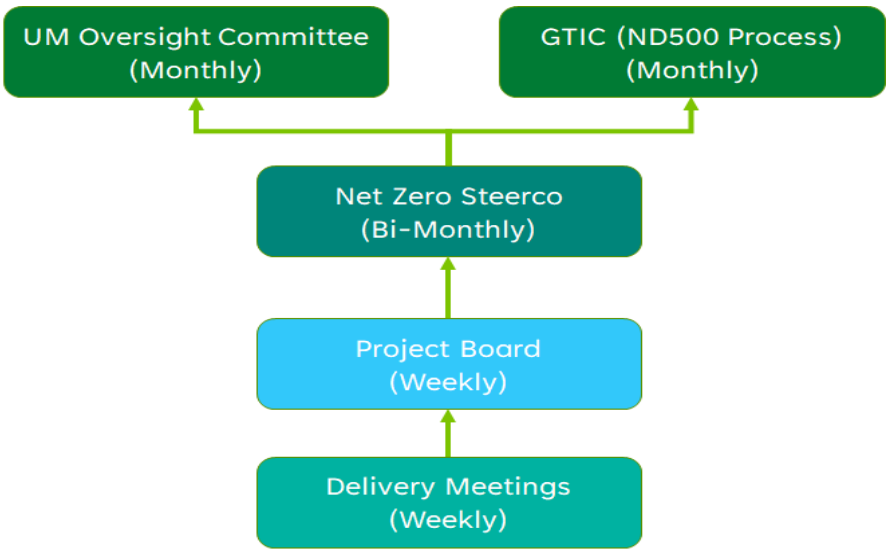


Figure 37 - Project Union Governance Structure

10.1.1 Key Meetings and Forums for Reporting Progress

Executive Meetings

There are three established executive level meetings Project Union will report into:

- **Uncertainty Mechanism (UM) Oversight Committee**

- Responsible for the management and decision making across the Uncertainty Mechanism portfolio. Re-opener submissions will be endorsed through this forum, and once submitted and approved monthly updates will be provided to this board, measuring progress through reporting on KPIs for quality, time and costs.

- **Gas Transmission Investment Committee (GTIC)**
  - Responsible for the management of investments through the ND500 process. Project Union funding requests will be presented to this forum as funds are required to proceed to the next phase of work.
- **Gas Transmission Innovation Group (GTIG)**
  - Responsible for the management of innovation investments and Use it or Lose it funding. Possibly a requirement to submit any bridging funding for the reopeners while we await a formal decision from Ofgem on the reopeners submitted so no momentum is lost on key activities.

Net Zero Steering Committee

The purpose of the Net Zero Steering Committee is to set strategic objectives for the project and resolve any blockers that may arise during delivery. This group manages inter-departmental priorities and challenges and drives alignment of strategic views across teams.

Project Board

The purpose of the Project Board is to share progress with the Project Sponsor and resolve issues within control of the project team. The Project Board supports alignment to Project Union's vision and strategy, as well as providing consistency across individual work packages. The Project Board brings together delivery teams from each of the sections covered under Project Union.

Delivery Team Meetings

Work packages have been established to support the delivery of this phase, across FEED and PU: Essential Enabling Activities outcomes. These work packages make up the delivery team structure, providing breadth of functional and technical expertise across the organisation. A Delivery Leads meeting will be held on a weekly basis to provide a progress update on each work package and to raise and concerns or risks.

10.2 Project Planning

10.2.1 Project Delivery Plan

[redacted]

This will be supported by a more detailed delivery plan which is outlined as one of the first deliverables to Ofgem as per the previous phase.

10.2.2 Deliverables

ND500 Deliverables

Table 27 outlines the proposed timelines for submission of materials against the ND500 process. Please note that these are indicative dates at this current phase and are subject to change as we progress through this current phase of work and more information is understood.

ND500 – Network Development Stage Gates and Key Milestones				
ND500 Phase	**Key Activities**	**Sanction**	**Indicative Date**	**Comments**
4.0 Needs Case 4.1 Establish scope and Options	• Identification of Needs case • Define strategic approach and outputs required to deliver • F1 sanction-Optioneering	T0	-	Not Applicable
		T1	-	Not Applicable
		F1	-	Not Applicable
4.2 Options Selection (Pre-FEED-F2) (FEED-F3)	• F2 Sanction-Feasibility • Agreement to Proceed to Conceptual Design • F3 Sanction-Conceptual Design and Long Lead items	T2	-	Not Applicable
		F2	-	Feasibility phase covered this sanction
		T3	-	Not Applicable
		F3	Aug-Sept 2024	Date dependent on consultation response
4.3 Conceptual Design and Development (Pre-Construction)	• Conceptual Design • Scope Freeze	T4	June-2026	Estimated date based on current plan-These dates are subject to change as we progress through this current phase.
4.4 Project Execution (Construction)	• F4 sanction-Detailed design and build • T5	F4	July-2026	
		T5	Aug-2026	
4.5 Acceptance/Closure	• Post commissioning handover to GT • Operational acceptance • Project Closure	T6	June-2031	
		F5	Sept-2031	

Table 27 - ND500 Network Development Stage Gates and Key Milestones

Ofgem Deliverables

Project deliverables are project specific outputs which demonstrate delivery of the project plan that funding is awarded for. These deliverables sit within the direction, meaning these should be met as a condition of receiving funding through the Re-opener and are listed in Table 28 below. Note that project deliverable deadlines are subject to a funding decision and expected start date of September 2024.

PU: St. Fergus to Teesside Deliverables

Reference	Work Package	Project Deliverable	Deadline	Evidence
PU:SFT1	Technical Delivery	Conceptual Design and FEED Summary	May-25 August - 26	1. Finalised short list of preferred technical option(s) to take forward to Conceptual Design 2. FEED Summary Document outlining progress of FEED for specified section
PU:SFT3	Lands and Consents	Consultation Strategy	May-25	Consultation Strategy in place
PU:SFT4	Lands and Consents	Route Corridor Study and Preliminary Route Report	August-25	Route Corridor Study and Preliminary Route Report
PU:SFT5	Construction / Technical Delivery	Construction Programme for Next Phase of work	May-26	End to end Construction Programme for next phase of work
PU: SFT6	-	Re-opener Closure Report	August-26	The report will set out: a. How this submission has been successfully delivered and any instances of under or non-delivery. b. How the project learnings have been shared with relevant stakeholders. c. Any further requirements set out in the Re-opener Governance Document. d. Will cover this current Re-opener and will be updated for subsequent closures

Table 28 - PU: St. Fergus to Teesside Deliverables

10.2.3 Mitigating Measures to Address Deviation from the Plan

Following a funding decision for this submission the proposed plan will be baselined and a critical path set for delivery. Following the Feasibility phase, we have considered the lessons learnt and developed a number of mitigations to avoid deviation from the plan and ensure delivery.

Time: Impacts to time or changes to the schedule should not be assessed in isolation. Any movement within a work package area can have an impact on the timelines as well as the critical path across the programme. Any extensions to time over one week will be subject to impact assessment and change control. When a time change is identified the work package lead will carry out an impact assessment with other work package leads to determine the impact. If the impact is deemed inconsequential then this should still be flagged with the Programme Management team for noting and work can continue with the change. Should there be a substantial impact across the work packages a change request should be made and submitted to the Project Board for assessment. This will allow early notification of changes so that they can be managed.

Cost: Increases in costs should all be subject to a change request. The Programme Management team should be notified so that assessments against finances can be made to understand the impact and logged.

Quality: Where quality does not meet required standards a meeting will be scheduled with the relevant parties and stakeholders to discuss and resolve these issues to avoid any rework. Linked to this is clear scopes of work, one key lesson learnt from the Feasibility phase is the necessity for a clear scope, where without one could lead to significant impact to the plan and deliverables.

10.2.4 Resource Management

Existing and new resources will be required to deliver PU: St. Fergus to Teesside outcomes. Resources will be agreed and ringfenced to this work to ensure that the delivery plan is achieved.

Hydrogen-related roles often require specialised knowledge and expertise in areas such as hydrogen production, storage, transportation, and utilisation. Finding candidates with the relevant knowledge and experience can be challenging due to the relatively small pool of professionals with this specific skill set and experience. As a result, recruiting for hydrogen-related roles requires proactive outreach and raising awareness to attract candidates and build a talent pipeline.

As interest in hydrogen continues to grow, competition for top talent in this space is intensifying. Companies across various sectors, including energy, transportation, manufacturing, and technology, are all vying for skilled professionals with expertise in hydrogen technologies and applications as we experienced when recruiting for the Feasibility phase of Project Union. This competition can make it challenging to attract and retain qualified candidates.

Regulatory and policy frameworks play a crucial role in shaping the growth and development of the hydrogen industry. However, uncertainty surrounding government incentives, regulations, and funding programs can create hesitation among job seekers and employers alike. Recruiting efforts may be impacted by this uncertainty, as candidates may be hesitant to commit to roles in an industry that faces regulatory ambiguity. Addressing these market challenges requires a targeted recruitment approach that emphasises education, awareness-building, and collaboration with industry stakeholders to attract and retain top talent in the hydrogen sector. This may involve partnering with educational institutions, participating in industry events and forums, and offering competitive compensation packages to attract candidates with the necessary expertise in hydrogen technologies and applications.

11. Regulatory Treatment and Impact

This chapter confirms the eligibility of this submission for funding under the RIIO-2 NZASP mechanism, outlines the range of benefits and reasons to socialise the cost of this submission across all gas consumers. We have taken a considered approach to identifying where we can minimise any impacts on consumer bills based on a clear set of principles and reflecting feedback from numerous constructive dialogues with Ofgem through this process.

11.1 Regulatory Funding Justification

11.1.1 RIIO-2 Innovation Funding

We considered Ofgem's RIIO-2 innovation stimulus package, noting Ofgem's ambition in RIIO-2 to refocus innovation funding on the energy system transition and its net zero responsibilities. RIIO-2 makes baseline funding provisions for NGT to support hydrogen projects within the RIIO-2 framework in two ways:

- **NIA:** baseline funding of £25m across the five-year price control period can be used to fund small and repeatable hydrogen projects, and the Gas Transporter licence makes provision for an increase in innovation funding specifically for hydrogen projects should Ofgem deem this necessary, and through consultation with relevant stakeholder groups.

- **SIF:** this is specifically targeted towards decarbonisation. The SIF is a competition-based mechanism which allows networks to apply for project funding against specific innovation "challenges" issued by Ofgem. A total funding pot across all electricity and gas networks of up to £450m has been signposted by Ofgem. SIF projects will follow three distinct phases, with individual applications required for each stage. Successful applications for earlier stages do not guarantee an outcome for subsequent stages. Materiality thresholds for project stages are specified as follows:
    - Discovery stage: capped at £150k
    - Alpha stage: capped at £500k
    - Beta stage: starting at £500k with any upper cap established in challenge round documentation.

11.1.2 Uncertainty Mechanism Funding

The RIIO-2 Framework also makes provision for managing uncertainty through a suit of mechanisms. In developing this submission, we also assessed the following relevant "Re-opener mechanisms" and "use it or lose it allowance mechanisms" as possible funding routes.

- **Net Zero and Re-opener Development 'Use It or Lose It' Allowance (NZARD UIOLI):** this mechanism provides £8.3m of baseline funding across the RIIO-2 period which can be used for low or no regret small net zero projects and for early development work on net zero projects to be brought forwards under the two Net Zero Re-opener mechanisms Ofgem have established for RIIO-2. The mechanism is subject to a £2m cap per project.

- **Net Zero Re-opener:** this is an Ofgem triggered mechanism designed to support larger scale net zero projects. Projects brought forward under this mechanism must exceed a materiality threshold of £10.7m. Triggering of the mechanism is contingent of the occurrence of a significant "Net Zero development" the detailed definition of which is included in the Gas Transporter licence.
- **NZASP Re-opener:** this mechanism allows Gas Transporter licensees to undertake early design, development, general pre-construction work, and net zero facilitation capital projects that will enable the achievement of net zero carbon targets. Broadly, the mechanism covers:
  - Early development / design and pre-construction work which is too material to be covered by the NZARD UIOLI allowance.
  - Net zero projects that are too material for the NZARD UIOLI allowance, but not material enough, or appropriate for the Net Zero Re-opener (see below)
    The mechanism can only be triggered by Ofgem following an extensive engagement phase to allow Ofgem determine when it is appropriate to establish a needs case in principle. Project must exceed £1m in value, with a specified upper limit of £100 million.
  - We have undertaken valuable and constructive bilateral engagement meetings with Ofgem which commenced in December 2023 and continued through to submission. We have provided a summary playback of these discussions in Appendix A.

11.1.3 Key Considerations in Determining Funding Eligibility

In establishing the most appropriate funding mechanism for this submission through existing RIIO-2 mechanisms, we considered several important factors ranging from project type, scale, relevant energy policy landscape to its interdependency with major projects to avoid non-duplication and a demonstration that gas network users will benefit from the expenditure:

- **Project type**: the proposal is to fund a submission for the potential repurposing of the transmission system, with some new build pipelines. The nature of the work to be undertaken would qualify under both the NZARD UIOLI allowance and the NZASP Re-opener, however the NZARD UIOLI allowance has a preventative upper limit of £2m per project and is therefore not suitable. We also assessed this project for funding against the criteria for RIIO-2 Innovation Funding Stimulus (NIA and SIF) but given the type and materiality of the project, we did not consider those mechanisms as suitable options.
- **Scale:** we anticipate that future phases will require more significant investment should the policy landscape support the need. However, for the scope of this proposal, project costs of **£98.497** million represent an increase of [redacted] on baseline Gas Transmission TOTEX funding for RIIO-2 which will have a minimal impact to payers based on our proposed regulatory treatment [see Chapter 11.3].
- **Policy alignment**: as demonstrated in Chapter 4, repurposing gas transmission assets is well aligned to relevant Government strategies, with the Government's position further developed in its minded to position on the Hydrogen Transport and Storage infrastructure[98] published in August 2023. We have worked with Government and Ofgem to share learnings from our Feasibility phase work to provide substantial evidence in

[98] Hydrogen transport and storage infrastructure: minded to positions (publishing.service.gov.uk)

support of Government decision making on policy, ahead of the development of the Business Model Design.

- **Interdependency with other projects**: Project Union will have implications for producers, transporters, and consumers. There is a significant complexity and lead-time associated with readying the hydrogen value chain, aligning any physical testing / trials and enabling regulations, codes, standards and commercial arrangements for changes in gas supply.
    - Project Union will act as a central contributor to aligning deliverables, assumptions and inter-dependencies allowing projects to link together in the most efficient manner to deliver net zero ambitions.
    - Through the Hydrogen in the National Transmission System (HyNTS) programme of work an extensive number of projects are being run alongside Project Union which will provide input and evidence into the feasibility of a hydrogen backbone and how it can be delivered for the best value to the UK as a whole.

11.2 Preferred Funding Mechanism

As explored above the RIIO-2 NZASP mechanism is the most suitable mechanism to fund this submission. In accordance with Ofgem's supporting governance document the NZASP has a broad scope, projects put forward under this mechanism must meet the following criteria:

- Early development, design and general pre-construction work that will enable the achievement of net zero carbon targets.
- FEED studies, conceptual design pre-FEED and general feasibility work required for large capital projects.
- Net zero projects that exceed the £2m materiality cap of the NZARD UIOLI allowance or are otherwise not suitable for the NZARD UIOLI allowance.
- Net zero facilitation (green Gas and hydrogen) projects and hydrogen projects that are required as part of the Department for Business, Energy & Industrial Strategy Hydrogen Grid Research and Development Programme, including projects that may be interpreted as innovative – where there is a clear need, and it is appropriate for network consumers to fund.

11.2.1 Funding Principles

In addition to section 11.1 Regulatory Funding Mechanisms Appraisal above, our pre-trigger engagement with Ofgem has provided valuable insight into key funding principles to be observed in the formulation of this Re-opener submission, and which can be used to inform the specific mechanics of regulatory treatment of proposed costs within the boundaries of established parameters for RIIO-2.

Of particular relevance to regulatory treatment are the following key principles:

- **Bill payers should continue be protected from undue cost exposure**: whilst the policy for the full role of hydrogen evolves. We carefully considered the implication of a "fast funding" approach which was utilised in the funding of the Feasibility phase of Project Union, in light of **increasing materiality.** The likely customer bill implications put to test the **durability of the "fast funded" approach.** Therefore, a different treatment will need to be considered to

minimise high upfront cost exposure to methane users especially where there is a direct customer bill impact in the short term.

- **Alignment with developing UK Government position**: In August 2023, DESNZ set out in its minded to position on the Hydrogen Business Model that a RAB based model will now form the basis of a future Business Models and it will need to be compatible with the future natural gas network price control. This approach could support the early stages of necessary regulatory architecture in line with Government intentions.
- **Net zero funding mechanisms within the RIIO-2 framework are primarily aimed at lower scale net zero projects and enabling works**. This has two broad implications for regulatory treatment of the proposed costs:
    - Limits the funding requests to reasonable and justifiable materiality thresholds.
    - This further underlines a view that TOTEX incentivisation as applied to investment in the methane network is not appropriate for Project Union FEED costs, and any cost savings should be returned in full.
- Other gas network hydrogen projects have been funded on the basis that they support building the evidence base needed to support Government policy and decision making.

These principles directly guide the proposed regulatory treatment that follows in this chapter.

11.3 Proposed Regulatory Treatment

Proposals made in this chapter are intended to apply on a non-precedential basis. This is because future policy clarifications may inform appropriate funding routes and specific regulatory treatments for subsequent project phases.

11.3.1 Cost Recovery Speed and TOTEX Incentivisation

Under the standard parameters included in the RIIO-2 PCFM, the NZASP Re-opener mechanism would be subject to TOTEX incentivisation with RAV capitalisation at 75%. However, given the funding principles noted above, we propose that the FEED Phase is not subject to TOTEX incentivisation but instead should be subject to a RAV capitalisation rate similar to regimes established for Uncertainty Mechanisms as above, added to TOTEX Allowance and funded through our (NZPt) terms in our license.

We also propose that **any underspend at the end of the project is fully returned** to network customers much like the Net Zero Use it or lose it allowance but where overspend is caused by increase to project expenditure due to events that we could not have reasonably foreseen activities and we have deemed that it is not economic and efficient to include in our contingency pot, an adjustment to the use it or lose it allowance to recover any overspend should be allowed.

11.3.2 Rationale for Cost Recovery Approach

A TOTEX funding approach not subject to the TOTEX Incentivisation, with a RAV capitalisation rate similar to regimes established for Uncertainty Mechanisms under the RIIO-2 framework and with any underspend at the end of the project fully returned is preferred as a viable alternative to previously relied upon fast-funded approach because;

(a) The increasing materiality across planned future re-opener applications and the need to protect methane customers from bill spikes puts to test the durability of the "fast funded" approach and in our view, full recovery via Fast money places an unfair burden on existing GT customers and contradicts some of the core principles of RIIO.

(b) The inability of a fast funded approach to facilitate equitable and fair intergenerational cost allocation which TOTEX founding allows for. In Ofgem's Sector Methodology (SSMC) - GT Annex, 2.4 - 2.5, Ofgem made it quite clear that with respect to the role of Hydrogen, In considering how network companies finance their investment, the plan must be to recoup past and future investments from current and future consumers and this means that there is merit in leaving some optionality for transfer of repurposable assets to third parties to protect consumers.

(c) It also allows for substantial parts of the cost to be captured in any future fair value transfer when considering asset repurposing, providing a route to target future Hydrogen users without burdening methane users with high upfront costs.

(d) A use it or lose it adjustment mechanism will also ensure that any underspend at the end of the project is fully returned, such that we should not get any net benefits as a result of any savings with an adequate mechanisms in place to recover any cost of overspend where costs would not have been foreseen for inclusion in the contingency pot.

(e) In a previous SQ response for Project Union East Coast Submission, we illustrated the impact of the various cost recovery approaches on bills, based on our total funding request across several scenarios; (a) Innovation Style Passthrough Funding, (b) TOTEX funding with RAV capitalisation based on asset transferring in FY27 as the Hydrogen Business Model is finalised in 2025 or (c) in 2031 when the build phase is expected to be completed, and in all of those approaches, Innovation Style Passthrough funding comes off worse for consumers because of the high upfront cost exposure with a direct customer bill impact in the short term.

(f) A TOTEX funding approach is more consistent with the principles of intergenerational cost allocation, better for consumers and consistent with a key pillar of Ofgem's consumer interest framework which is the need to ensure "Low-cost transition";

The NZASP Guidance makes provisions for Ofgem to direct a different split between upfront funding and longer-term fund (through the regulatory asset value) where it is deemed most appropriate.

11.4 Benefits to methane network users

Project Union reduces consumer costs by offering the opportunity to extend the economic life of the current methane assets and the proposed activities for FEED will support the realisation of several benefits to existing and future gas network users that repurposing can offer, including:

- **A whole system approach utilising transmission scale hydrogen will deliver benefits to consumers by**: Reducing renewable generation curtailment from 26% down to 1% by 2050,

providing energy system savings up to £38 billion by 2050 and providing the flexibility and security to electricity systems[99].

- **Direct decarbonisation pathways:** Net zero transition will be a multi-decade journey with sectors and geographies decarbonising under varying timeframes. As policy evolves, it is vital that the UK develops optionality for viable and affordable decarbonisation pathways for methane users to reach net zero while leaving no one behind.

- **Accelerated wider use of hydrogen**: Access to hydrogen for power generation and energy storage will enable a net zero power grid by 2035, and an overall lower cost and more secure energy system.

- **Mitigation of stranding risks**: Asset repurposing will mitigate potential future stranding risks and costs, potentially supporting lower bill profiles in the near term, by mitigating (or even reversing) accelerated depreciation of the gas RAV.

- **Further strengthen incentives to enhance and maintain the methane network:** it will be more attractive to invest in maintaining, upgrading and extending the economic asset life of the methane network in the near term if there are viable futures to repurpose well maintained assets to transport hydrogen. Without such incentives, ongoing investment in the methane network could move into a "managed decline" scenario to the detriment of performance and reliability (subject to underlying minimum standard obligations).

- **Operational synergies:** in a transitional period, the methane and hydrogen networks would coexist. This would mean that company level business support costs required to support the methane and hydrogen networks (for instance head office costs, IT costs and centralised functions such as finance, procurement and legal) would be shared over a wider asset base. There may also be opportunity lever greater buyer power in the relevant marketplaces, and greater efficiency in work planning and scheduling where internal resources and capabilities are interchangeable between methane and hydrogen assets.

- **Financial benefits**: where a RAV based model is adopted for both, collective management of methane and hydrogen investments it provides the opportunity to pool financial risks. This might further mitigate the need to accelerate depreciation of the methane RAV, potentially supporting lower and flatter bill profiles for methane users during the net zero transition.

- **Reduces decommissioning liabilities associated with network redundancy:** where elements of the existing methane network can be re-purposed, this will extend the economic life of the relevant asset, avoiding the need for decommissioning costs in the near and long term.

- **Alleviate the risk of cost increases to a smaller user base**: Cost increases driven by a combination of declining user base and accelerated depreciation could be alleviated with natural gas users benefiting from cost reduction and transfers from repurposing the existing network.

[99] Guidehouse (2023), GETIO: Gas and Electricity Transmission Infrastructure Outlook 2050 (nationalgas.com)

12. Adopting a proportionate approach to evidence

Network companies are required to consider the proportionality of the evidence provided in support of Re-opener applications, and to that end the following key factors have shaped the structure, content and scope of this application:

1. Government policy on the full role of hydrogen in a net zero future continues to evolve. However, policy indicates a clear signal for hydrogen, and it is essential that this is supported with the development of infrastructure and a liquid, competitive UK wide market.

2. Market conditions for a hydrogen economy are in their very early stages and will rapidly advance over the next decade.

3. Our stakeholder engagement has consistently demonstrated a need for Project Union to allow hydrogen producers, storage operators and end users to plan their own schemes and to enable a hydrogen market to develop as early and efficiently as possible.

4. Delivering FEED through a targeted regional phase, for St. Fergus to Teesside, ensures we can deliver a focused evaluation. Project Union: Essential Enabling Activities accompany this approach as to integrate insights obtained from Hydrogen Market Enabling activities and continued development of the Phasing Strategy and Funding aspect. This collaborative approach maintains flexibility and optionality as Project Union: Essential Enabling Activities are completed in tandem, to a St. Fergus to Teesside focused FEED, to ensure efficiencies across the programme.

5. European policy for hydrogen continues to evolve with targets of 20 Mt of hydrogen production capacity targeted by 2030, half of which are imports. A UK hydrogen backbone connected to a wider European Hydrogen Backbone will enable continued cross border trade and access to emerging European and Global hydrogen markets.

6. Given the length of time required to plan for and deliver critical national infrastructure, if the UK is to achieve its net zero targets by 2050, there is a clear need to act now and at pace. Delivering this next phase of work now will position the UK to progress more swiftly on the most economically advantageous and effective pathway to a hydrogen economy by enabling infrastructure to keep pace with developing hydrogen supply and demand.

7. Net zero mechanisms were introduced by Ofgem under the RIIO-2 framework designed to work as a coherent package of measures to ensure network companies have sufficient flexibility to bring forward both strategic network investments for net zero and respond to changes in network requirements. Until alternative arrangements for the funding of hydrogen activities can be implemented, utilisation of the RIIO-2 net zero mechanisms provides the best currently available option to undertake necessary preparatory work, and we consider this to be appropriate given that the scope of this submission relates to current regulated assets, offering significant benefits to existing consumers either by avoiding asset stranding

or future decommissioning costs, or through providing future options to access zero carbon energy.

The evidence provided in this submission reflects the nature of these important considerations, and we have aimed to strike an appropriate balance given the uncertainties involved, the "first of a kind" nature of the project of the funding proposed:

- We demonstrate how our proposed works address key gaps in the evidence base required to support future policy decisions regarding hydrogen infrastructure across topics of the role of a hydrogen backbone in a future energy system, engineering and asset readiness, regulatory framework and funding options.

- We undertook an assessment of the societal benefit of a Project Union backbone, to ensure a compelling needs case that is robust to future uncertainty.

- We show how we have optimised the use of existing net zero baseline and innovation funding routes to minimise the amount of additional funding being proposed.

- We took a phased approach to project development, meaning that funding is proposed only for those critical activities and outcomes that will allow the project to progress through FEED and that are enabling to future project phases. This approach has a number of benefits:
    - Allows Government and Regulatory policy to evolve alongside the progression of the project
    - Ensures congruence with the current policy position, and significantly protects against the risk of sunk investment now and in the future
    - Minimises cost and risk exposure to bill payers whilst ensuring sufficient funding to avoid regulatory burden for multiple separate submissions

- The proposed funding is primarily aimed at building evidence where evidence does not currently exist. As such the current maturity of information and data does not lend itself to the level of quantified analysis that would support a typical methane network investment decision. Instead, we seek to evolve and iterate over time through a phased approach, at each stage making step changes in the level and quality of information available. Pre-FEED activities have been undertaken for the whole hydrogen backbone enabling the broadest evidence base to inform decisions on future phasing. By utilising this evidence and information FEED activities can progress through a phased delivery ensuring the most optimum solutions are proposed, in alignment with developing policy, minimising uncertainty and keeping investment costs relatively low.

- Given the value of the proposal, it is imperative that the project has demonstrable value to current bill payers under the Gas Transmission RIIO-2 framework, which we address within this submission.

13. Assurance

As a part of our assurance obligations required under Ofgem's Re-opener Guidance we will provide confirmation from our Regulation Director who is accountable for the RIIO-2 regulatory allowances to provide assurance that the three assurance points requested by Ofgem have been met in our final submission. These three points and activities that will be undertaken include:

It is accurate and robust, and that the proposed outcomes of the Re-opener are financeable and represent good value for consumers.

- The application that will be submitted will have been prepared by a multi-disciplinary team involving leaders and experts from UK Regulation, Gas Transmission and System Operations. Iterative internal challenge and review between these teams supports the accuracy and robustness of the proposals.
- The relevant senior leaders will confirm support for the Re-opener proposals in terms of needs case, consumer benefits, deliverability and alignment with wider business strategy.
- Value to consumers is demonstrated through investment to develop a Hydrogen ready network aligning with Government net zero targets.

There were quality assurance processes in place to ensure the licensee has provided high-quality information to enable Ofgem to make decisions which are in the interests of consumers.

- The information in the submission and supporting files will, as a minimum, been subject to both peer review and approval by a manager more senior than the author.
- Calculations of proposed allowances presented in the Re-opener submission will be assured by the relevant Finance Business Partners.
- The submission will be subject to robust assurance and accompanied by supporting information which includes the relevant Data Assurance Governance (DAG) Submission Assurance Reports and Risk Assessments.
- The submission will include a table that maps out which sections of the application relate to individual requirements as set out in the relevant Re-opener license condition and NZASP guidance.
- Contents of this submission have been discussed with Ofgem in a series of pre-/post-trigger multi-lateral, and bi-lateral, engagement meetings taking place between December 2023 until final submission in August 2024. The purpose of these sessions is to support the agile, efficient and proportionate process for Re-openers outlined by Ofgem in Final Determinations. We will take on board Ofgem's feedback from those sessions leading us to understand that our submission provides a proportionate amount of evidence in regard to the value of allowances and complexity involved.

The submission has been subject to internal governance arrangements and received sign off at an appropriate level within the licensee

The above points will be re-confirmed within our final submission of this Re-opener alongside our DAG Assurance Assessment. [redacted]

14. Glossary of terms

Term	Definition
AGI	Above Ground Installation
ASTI Framework	Accelerated Strategic Transmission Investment Framework
BAU	Business as Usual
CAPEX	Capital Expenditure
CBA	Cost Benefit Analysis
CCC	Climate Change Committee
CCUS	Carbon Capture Utilisation and Storage
CPIH	Consumer Price Index (including owner occupiers' housing costs)
CPO	Compulsory Purchase Order
CT	Customer Transformation
DAG	Data Assurance Governance
DCO	Development Consent Order
DESNZ	Department of Energy Security and Net Zero
DLUHC	Department for Levelling Up, Housing and Communities
DN	Distribution Network
DST	Decision Support Tool
EIA	Environmental Impact Assessment
ENA	Energy Networks Association
EPC	Engineering, Procurement and Construction
FEA	Formal Environmental Assessment
FEED	Front-End Engineering and Design
GDN	Gas Distribution Network - There are eight individually licenced gas network areas operated by four companies: Cadent, Northern Gas Networks (NGN), SGN and Wales & West Utilities (W&WU). The GDNs are supplied with most of their gas from the NTS and deliver it to industrial, commercial, and domestic customers
GI	Ground Investigation
GIS	Geographic Information System
GT	Gas Transmission
Gt	Gigatonne
GTIC	Gas Transmission Investment Committee
GTIG	Gas Transmission Investment Group
GVA	Gross Value Added - The value generated by any unit engaged in the production of goods and services
GW	Gigawatt
H2 MOP	Hydrogen Maximum Operating Pressure
HAR1	Hydrogen Allocation Round
HPBM	Hydrogen Production Business Model

HTBM	Hydrogen Transport Business Model
HyNTS	Hydrogen in the National Transmission System
IGEM	The Institution of Gas Engineers and Managers
IGEM/TD/1	The Institution of Gas Engineers and Managers standard covering design, construction, inspection, testing, operation and maintenance of steel pipelines and certain associated installations for the transmission of dry natural gas
ILI	In-Line Inspection - an internal inspection technique for our pipelines
LCHA	Low Carbon Hydrogen Agreement
LCP	Least Constrained Path
LPA	Local Planning Authority
MCA	Multi-criteria Analysis
MEL	Mutual Energy Limited
MOP	Maximum Operating Pressure
MOU	Memorandum of Understanding
MPT	Multi-criteria Phasing Tool
Mt	Million tonnes
MW	Megawatt
ND500	Gas Network Development Process - ND500 is the governance process that defines the end-to-end lifecycle of projects in NGT
NESH$_2$A	The North-East Scotland Hydrogen Ambition
NESO	National Energy System Operator
NGN	Northern Gas Networks
NGS	National Gas Services
NGT	National Gas Transmission
NIA	Network Innovation Allowance
NIC	National Infrastructure Commission
NPV	Net Present Value
NTS	National Transmission System
NZARD	Net Zero and Re-opener Development
NZARD UIOLI	Net Zero and Re-opener Development Use It Or Lose It. A funding approach whereby unspent money is clawed back
NZASP	Net Zero Pre-Construction Work and Small Projects Reopener - This mechanism allows Gas Transporter licensees to undertake early design, development, general pre-construction work, and net zero facilitation capital projects that will enable the achievement of net zero carbon targets
NZHF	Net Zero Hydrogen Fund
OEM	Original Equipment Manufacturer
OPEX	Operational Expenditure
PCFM	Price Control Financial Model

PEIR	Preliminary Environmental Information Report
PINS	Planning Inspectorate
PU	Project Union
PU: East Coast	Project Union: East Coast
PU: Essential Enabling Activities	Project Union: Essential Enabling Activities
PU: North West	PU: North West
PU: St. Fergus to Teesside	Project Union: St. Fergus to Teesside
QS	Quantity Surveyor
RAB	Regulated Asset Base
RAV	Regulatory Asset Value - The value ascribed by Ofgem to the capital employed in the licensee's regulated transmission business.
RFI	Request For Information
RIIO-2	Revenue = Incentives + Innovation + Outputs (Ofgem's regulatory framework)
RPE	Real Price Effects - Expected changes in input prices, e.g. wages, relative to the Retail Price Index (RPI)
RPI	Retail Price Index - An aggregated measure in changes in the cost of living in the UK
SHFCA	The Scottish Hydrogen and Fuel Cell Association
SIF	Strategic Innovation Fund
SME	Subject Matter Expert
SoCC	Statement of Community Consultation
SSMC	Ofgem's Sector Methodology
ST	System Transformation
TCPA	Town and Country Planning Association
TIM	TOTEX Incentive Mechanism
TOTEX	Total Expenditure - Totex generally consists of all the expenditure relating to a licensee's regulated activities but except for some specified expenditure items. The annual net additions to RAV are calculated as a percentage of the Totex
TWh	Terrawatt hours
UM	Uncertainty Mechanism

15. Figures, Tables and Supplementary Documents

[redacted]

16. Appendices

Appendix A - Ofgem Pre-Trigger Engagement

Where a licensee intends to access funding via Net Zero Re-opener mechanisms, Ofgem's associated governance and guidance document require that networks undertake a period of pre-trigger engagement with the regulator to establish a needs case in principle.

We have undertaken valuable and constructive engagement with Ofgem through a series of regular multi-lateral discussions commencing December 2023.

Table 30 below summarises this engagement, linked to the required topic areas specified in the governance document:

Engagement Requirement	Information Shared
What is being proposed?	- Detailed needs case across hydrogen demand, production and storage within the region - Proposed scope, project objectives - Re-opener submission content
The project cost	- Discussion surrounding scope of works and associated project costs including internal/external split and total cost
The aim of the project and evidence that it fits into wider strategic goals	- Vision and aims for the project - Alignment to strategic objectives
Why is it appropriate for this to be funded by network consumers through this re-opener?	- Gas network user benefits including socio-economic benefits and benefits of a Net Zero Power Grid - Distribution of costs through transmission charging - Customer bill implications under different regulatory funding models
How the funding should be treated from a regulatory point of view?	- Working assumptions on suitability of funding treatment under Innovation and TOTEX models
The timelines for the project including its anticipated length and the submission dates for the detailed assessment phase	- Updates to expected project timelines were shared on a regular basis - The timings for detailed submission evolved as part of the engagement

Table 29 - Pre-trigger engagement requirements

As part of our pre-trigger engagement with Ofgem we have held a series of meetings to discuss the progress and strategic direction of PU: St. Fergus to Teesside. These meetings have been informative in helping us to build out our re-opener scope and structure. A summary of the engagement held with Ofgem to date is included in Table 30 below.

Date	Attendees	Key Discussion Points
05/12/2023	[redacted]	- Introduction of PU: St. Fergus to Teesside as an upcoming Re-opener submission - Working assumptions on suitability of NZASP regulatory funding - Customer bill implications of this funding approach Alignment to Ofgem engagement activity: Why it is appropriate for this to be funded by network consumers through this re-opener? And how the funding should be treated from a regulatory point of view?
18/01/2024	[redacted]	- Overview of the value proposition associated to PU: St Fergus to Teesside - PU: St Fergus to Teesside needs case/storage potential - Projected costs and work package breakdown - Re-opener submission/project delivery timelines Alignment to Ofgem engagement activity: What is being proposed? The project cost, and the timelines for the project including its anticipated length and the submission dates for the detailed assessment phase.
09/04/2024	[redacted]	- PU: St. Fergus to Teesside pre-trigger engagement requirement checklist
13/08/2024	[redacted]	- Revisit Project Union regional split/submission timelines - Re-cap of alignment to strategic goals and evidence to support the need. Alignment to Ofgem engagement activity: The aim of the project and evidence that it fits into wider strategic goals.

Table 30 - Summary of Ofgem pre-trigger engagement

Appendix C - Redaction Explanatory Statement

The "Project Union: St. Fergus to Teesside Net Zero Pre-construction Work and Small Net Zero Projects Re-opener" was submitted to Ofgem on 30th August 2024 and will be subsequently published on our website 5 working days following submission, in accordance with Special License Condition 3.9.5 and RIIO-T2 Re-opener Guidance and Application Requirements Document: Version 3.

As with our RIIO-T2 Business Plan, we publish all documents in as full a form as possible to assist stakeholders in considering the information. However, given the nature of our business it has been necessary to redact certain confidential information from the documents we are publishing. This summary statement explains the reasons for our redactions.

Commercially Confidential information

Certain information contained within these documents is classified as "Commercially Confidential" to National Gas Transmission as it contains competitively sensitive information. This type of information identifies or could reveal the cost data of our assets or activities that we source from 3rd party providers on a competitive basis (e.g., goods and services in relation to the construction, operation, and maintenance of our network). Publishing this data would be prejudicial to the commercial interests of National Gas Transmission and therefore, would be prejudicial to the interests of consumers.

Chapter 1 of the Competition Act 1998 prohibits the exchange of competitively sensitive information, therefore publishing any of this type of information would be unlawful.

Information of this nature has been redacted from the documents published.

Information has also been redacted from the documents published on the basis that it relates to our future potential contractors and suppliers, which have not yet been subject to a procurement process. Publishing this information would be prejudicial to the commercial interests of National Gas Transmission and therefore our customers and end consumers.

Applicable to:

- Chapter 1 Executive Summary
- Chapter 3 Project Description
- Chapter 5 Needs Case
- Chapter 7 Options
- Chapter 9 Cost Information

Third Party Information

Certain information contained within the documents published may relate to or has been provided or produced by a third party.

Certain information within these documents relates to a particular third-party individual or business. Section 105 of the Utilities Act 2000 provides that such information cannot be disclosed by us save in limited circumstances or with the consent of the individual or person carrying on the

business. Information of this nature has been redacted from the documents being published today where we do not have this consent.

Applicable to:

- Chapter 5 Needs Case
- Chapter 6 Stakeholder Engagement and Whole System Opportunities
- Chapter 9 Cost Information

Contact:
Danielle Stewart
Hydrogen, Commercial
E: Danielle.Stewart@nationalgas.com

Tony Nixon
Regulation, Commercial
E: Tony.Nixon@nationalgas.com

nationalgas.com