Project Union: East Coast

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

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Key Contacts

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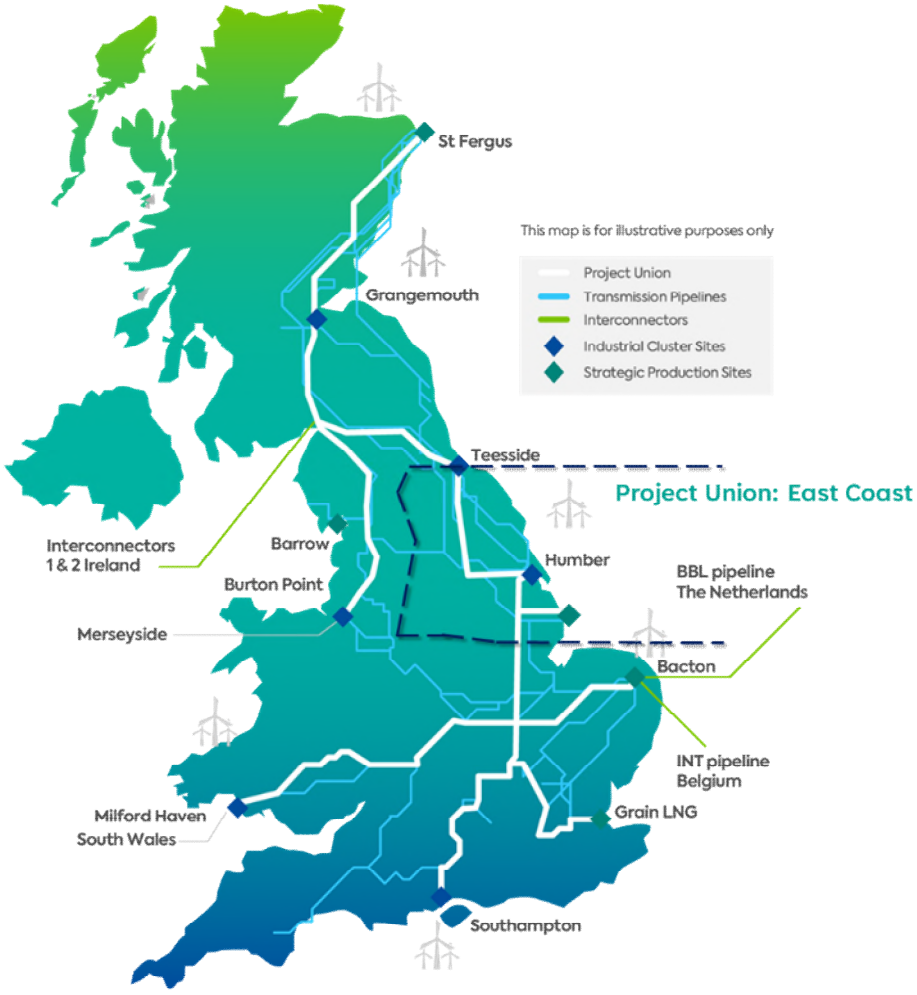
ProjectUnion: East Coast

28.3 TWh/year
Of industrial and power demand connected through direct connects by 2030

Up to 11.6 GW
Of planned hydrogen production could be enabled by PU: East Coast as part of ECH$_2$

3.6 TWh
Potential Hydrogen storage capacity from Rough Gas Reservoir and Aldbrough by 2030

Up to 375km
Of repurposed natural gas pipelines reducing new infrastructure required



Key Deliverables

1	**East Coast FEED** – Will identify a preferred routing option from the options identified during pre-FEED, where a revised options list will undergo conceptual design, lands and consents activities will be continued, and procurement activities will be commenced.
2	**Project Union: Essential Enabling Activities** – Programme of work critical to ensuring a fully operational and accessible hydrogen transmission network. It will support the delivery of FEED and essential to ensure a fully operational network through demonstrating the potential to repurpose, defining operating procedures, adapting existing systems and assets for hydrogen, and developing and delivering a transition plan and governance structure to deliver FEED and further phases of Project Union.

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Management approval

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Danielle Stewart	Project Director – Project Union	Apr-24
Tony Nixon	Regulation Director	Apr-24
Martin Cook	Chief Commercial Officer	Apr-24
Nick Hooper	Chief Financial Officer	Apr-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 a starting point with sufficient production

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

capabilities, storage capacity, network connectivity and concentrated demand. The East Coast region supports the fulfilment of these requirements, as a central location of concentrated industrial sites, including two of the largest industrial clusters, Teesside and the Humber, large scale gas storage capacity and offshore wind power. The region aims to be a foundation upon which the UK can build its hydrogen economy, delivering decarbonisation, resilience, energy security, and green economic growth. Project Union: East Coast (PU: East Coast) will develop a transmission network within this region, transporting 100% hydrogen, and will be the first stage of the development of Project Union in order to deliver a UK wide backbone.

In developing options for both the full Project Union backbone and PU: East Coast specifically, the repurposing of existing National Transmission System (NTS) pipelines for hydrogen has been prioritised due to the significant environmental, cost and time benefits that this approach provides. The preferred option for PU: East Coast 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, a full new build option has also been developed and both solutions will initially be carried forward into FEED. The benefits of the repurposing approach are so significant that this approach is considered appropriate.

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 £81.829m (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:

- **East Coast FEED** – Will identify a preferred routing option from the options identified during pre-FEED, where a revised options list will undergo conceptual design, lands and consents activities will be continued, and procurement activities will be commenced.

- **Project Union: Essential Enabling Activities** – Programme of work critical to ensuring a fully operational and accessible hydrogen transmission network. These packages of work will support the delivery of FEED and ensure a fully operational network through demonstrating the potential to repurpose, defining operating procedures, adapting existing systems and assets for hydrogen, and developing and delivering a transition plan and governance structure to deliver FEED and further phases of Project Union.

East Coast 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 (PU: Essential Enabling Activities) are required to deliver FEED and support further phases of Project Union irrespective of the section being developed.

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: East Coast will demonstrate the case for a cost-effective hydrogen transmission network for the East Coast 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	Total
[redacted]						
2018/19	[redacted]					81.829

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 a 15-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: East Coast, as well as broader phasing and market enabling activities for the wider Project Union programme.

- Project Description: This chapter outlines the wider project and work carried out to date as well as PU: East Coast 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: East Coast, 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 East Coast 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 this 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: East Coast, 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.

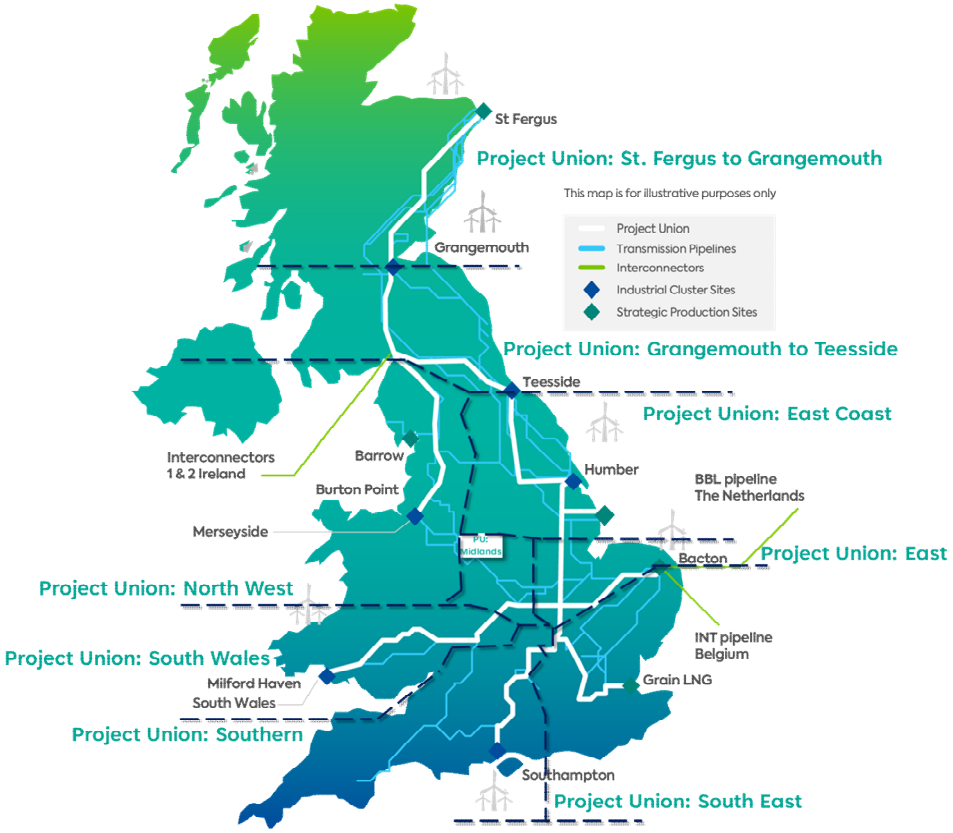


Figure 2 - Project Union Map (Illustrative) This map illustrates the breakdown of sections used to inform the technical options assessment; sections included in funding submissions may be a combination of these sections

In April 2023, NGT was awarded £5.626m (18/19 prices) of regulatory funding via the NZASP Re-opener to carry out the Feasibility phase of Project Union. The Feasibility phase had three key outcomes:

- **Phasing Strategy**, including prioritisation and timing for delivery of each section of the hydrogen backbone while ensuring security of supply on the remaining methane network. It will also deliver a staged approach to project delivery and funding.
- **Pre-FEED** activities for a full hydrogen backbone, delivering an appraised set of routing options, a constructability assessment and a planning and consenting strategy based on enhanced cost estimates and asset data. A full engineering policy review will also be undertaken.

- **Hydrogen market enabling activities** including a supply chain assessment and ongoing customer and stakeholder engagement.

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: East Coast, in addition to PU: Essential Enabling Activities to support the delivery of a fully operational network.

PU: East Coast

This submission involves the connection of two of the largest industrial clusters in the UK, Humber and Teesside, while connecting these clusters with hydrogen production, storage and demand sites. The East Coast region provides a logical starting point for the build out of a hydrogen transmission backbone. This is due to the East Coast's readiness to accept hydrogen and the demand for a hydrogen transmission network, with production scaling as part of Track 1 cluster development accounting for accelerated decarbonisation.

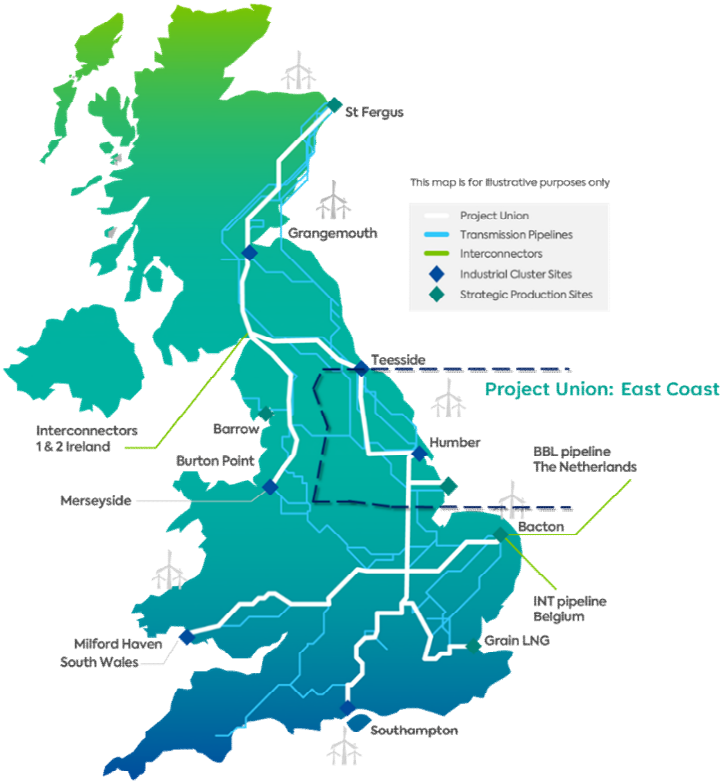


Figure 3 - East Coast boundary

Figure 3 shows the boundary of the East Coast section, the region in which this submission's FEED focuses on (it should be noted that PU: Essential Enabling Activities are required to ensure ongoing needs of customers are met and a hydrogen backbone is operational and can be managed effectively once delivered). This will allow NGT to begin its transition to developing a hydrogen

transmission backbone, and one that will support the East Coast Hydrogen (ECH_2) programme[5] in its regional roll out of hydrogen across both transmission and distribution.

This phase will demonstrate the case for a cost-effective hydrogen transmission network for the East Coast 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 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 £81.829m[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. Therefore, across all options, where asset solutions were required, the consideration of repurposing pipelines was a priority over new build pipelines due to these benefits.

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 innovations 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 East Coast region by the current target dates. To mitigate this risk, a full new build option has also been developed as part of the

[5] East Coast Hydrogen Delivery Plan - East Coast Hydrogen
[6] 2018/19 Price – base year for RIIO-2 price control period

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 timeline for the delivery of PU: East Coast progressing with FEED, as well as PU: Essential Enabling Activities, such as Phasing and Market Enabling activities delivered over a 24-month period. The proposed structure of this phase is to ensure technical and non-technical work aligns to deliver an operational hydrogen transmission network at the right time. As part of this submission we propose to progress FEED on two options, a repurposed option and a fully new build option, as described above, until such time as re-purposing can be confirmed. At this point development of the new build option would stop. This approach will minimise any impact on the project timeline should the repurposing option be ruled out.

Subsequent PU: East Coast specific phases as well as wider Project Union phases will be delivered in parallel. Our proposed staged delivery approach will account for evolving market and customers' needs and deliver optionality for consumers whilst limiting their exposure to cost and risk of the transition.

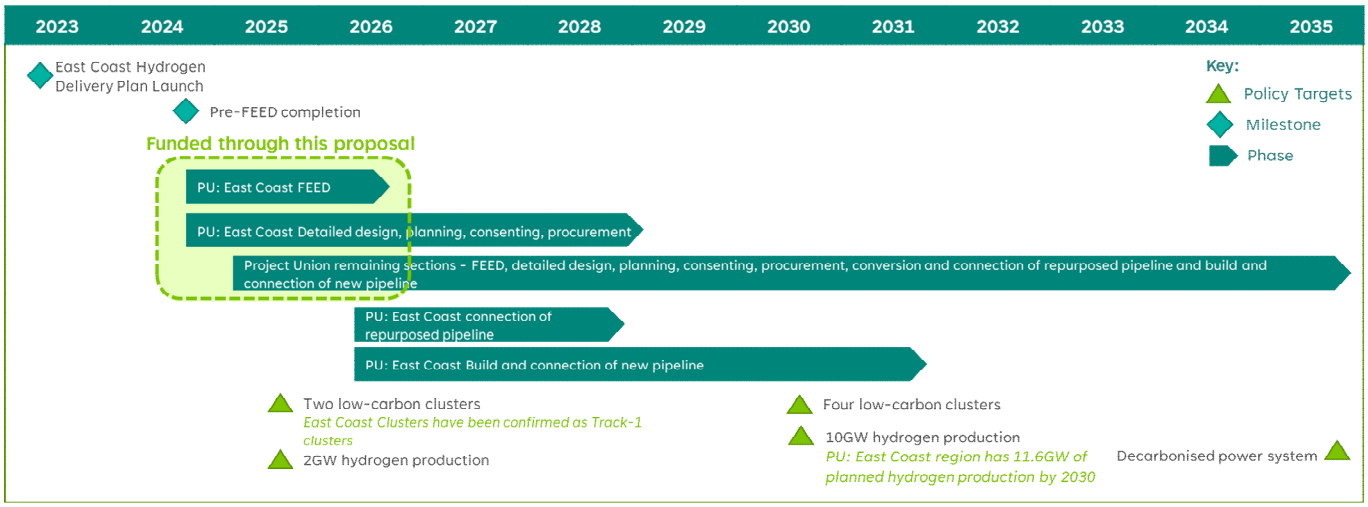


Figure 4 - PU: East Coast Delivery Plan

In accordance with the relevant terms of the Licence, this application is made at the invitation of Ofgem following a ten-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[7,8]. [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 we operate a secure, resilient network, making the necessary investments on the remaining gas

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

network to enable the transition to the hydrogen network of the future. Figure 5 outlines our purpose, values, and priorities.

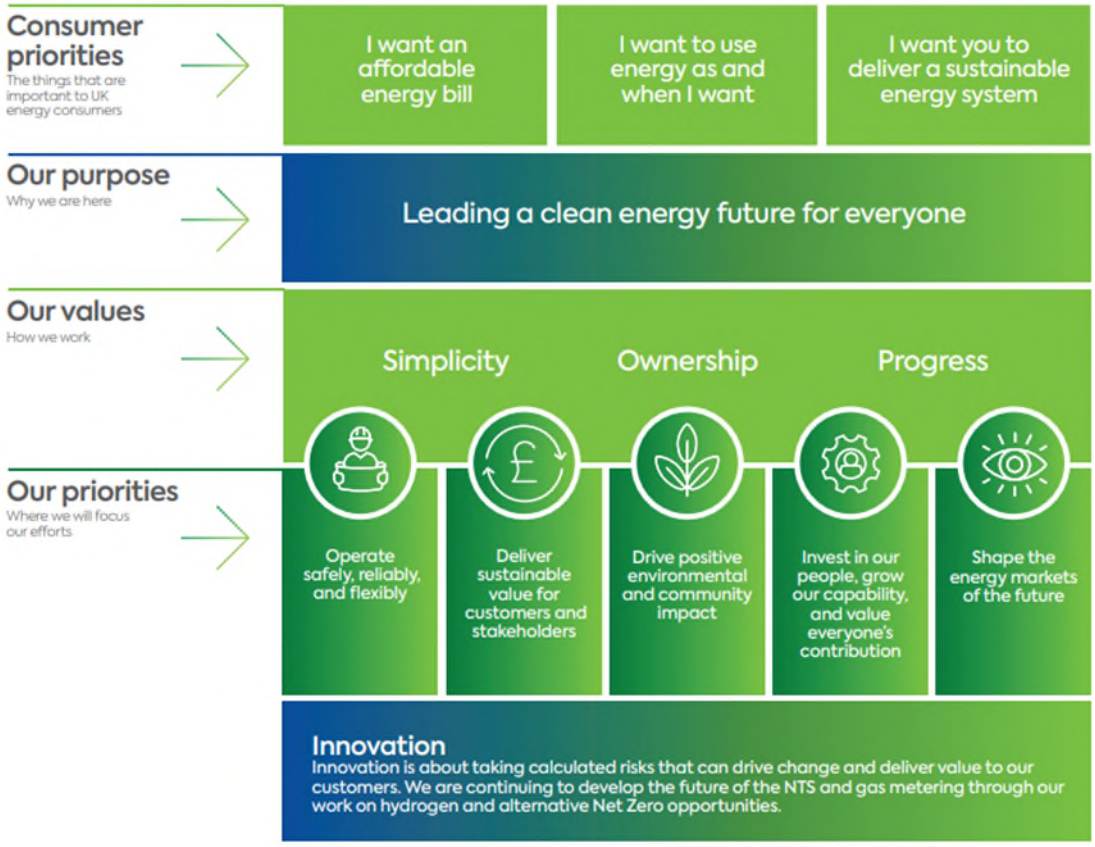


Figure 5 - Our purpose, values, and priorities

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. 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 2019, the decarbonisation policy landscape has continued to evolve, Figure 6. The UK Government has continued in its 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.

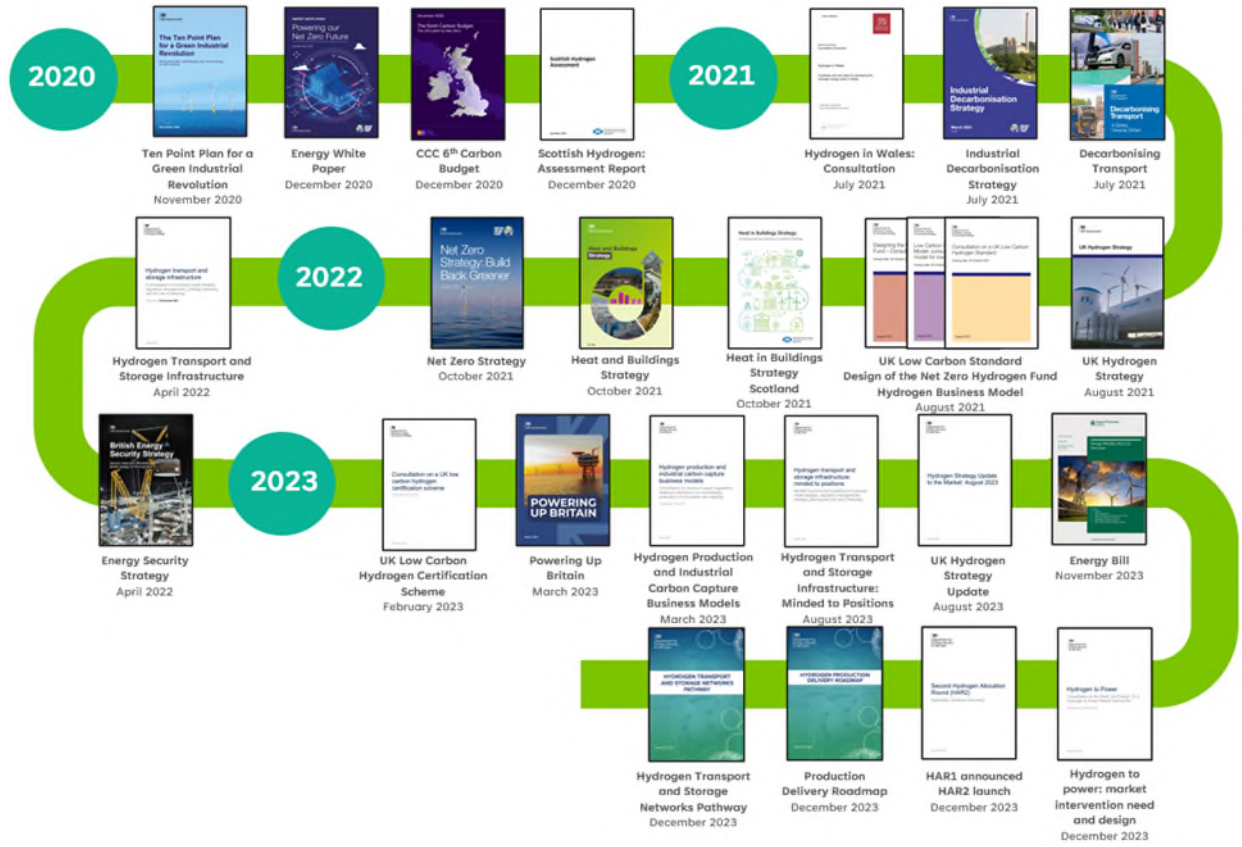


Figure 6 - UK decarbonisation policy landscape

Several Government policies highlight targets and ambitions relating to hydrogen:

- Hydrogen Transport and Storage Business Model due in 2025[9]
- 10GW Hydrogen production capacity by 2030 (UK)[10]
- 5GW Hydrogen production capacity by 2030 and 25GW by 2045 (Scotland)[11]
- Distribution level blending expected at the earliest 2025-26
- Net zero power system by 2035[12]

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

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

the UK Government promotes 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. Appendix A outlines the alignment of PU: East Coast with these wider strategic goals.

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 highlights the ambition for near term support of hydrogen storage projects and associated regional pipeline infrastructure. Project Union aligns with the strategic priority to enable decarbonisation of industry and power, delivered through a core network expansion approach. PU: East Coast will enable the early build-out of emerging regional hydrogen networks through connecting production and demand to suitable storage at scale by the mid -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.

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[13]. With hydrogen playing a critical role in supporting European-wide government climate commitments, Project Union provides the opportunity to connect 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[14]. 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[15]. 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.

[13] Global Hydrogen Review 2022 – Analysis - IEA
[14] International Hydrogen Progress Index – Energy Networks Association (ENA)
[15] UK slips down the International Hydrogen Progress Index – Energy Networks Association (ENA)

Within the British Energy Security Strategy[16], 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[17] 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[18] explores how extensive national infrastructure networks for Carbon Capture Utilisation and Storage (CCUS) and hydrogen can lower overall residual emissions from UK industry by reaching dispersed sites that cannot fully electrify. As explored in the Project Union NZASP Re-opener[19], Project Union will connect the large industrial clusters with strategic production sites and storage and provide hydrogen access to dispersed sites supporting a resilient hydrogen economy and liquid hydrogen market that lowers costs for consumers.

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. This evidence base will be used to demonstrate the evidence for implementing blending. A future decision on whether to enable blending is therefore expected by Government, with given timescales expecting blending to commence at the earliest 2025-26. Project Union will facilitate these trials by providing energy resilience and security to the wider network and regions. However, it should be noted that the requirement for an integrated UK hydrogen backbone, is not contingent on the positive hydrogen in heating decision.

[16] British energy security strategy - GOV.UK (www.gov.uk)
[17] Energy Bill [HL] - Parliamentary Bills - UK Parliament
[18] Industrial decarbonisation strategy - GOV.UK (www.gov.uk)
[19] Project Union Feasibility Phase NZASP Reopener

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[20], 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[21]

5.1 East Coast

The development of a national hydrogen supply chain will require a starting point with sufficient production capabilities, storage capacity, network connectivity and concentrated demand. PU: East Coast fulfils these requirements, as a central location of concentrated industrial sites, large scale gas storage capacity and offshore wind power, it will anchor the decarbonisation of the East Coast region through hydrogen production from multiple sources connected to a variety of demand points.

The region aims to be a foundation upon which the UK can build its hydrogen economy, delivering decarbonisation, resilience, energy security, and green economic growth. PU: East Coast will allow NGT to begin its transition to developing a hydrogen transmission backbone, and one that will support the ECH_2 programme[22] in its regional roll out of hydrogen across both transmission and distribution.

The market need to embed hydrogen into the region's operations, outlines the requirement for kick starting the next phase of delivery, now. This will ensure that an operational hydrogen pipeline network will be present at the required timescale of customer network demand. Given the length of time required to plan and deliver critical national infrastructure, if the UK is to deliver 10GW hydrogen production capacity and support an affordable energy system with 50GW offshore wind by 2030, there is a clear need to act now. This will ensure that we are able to meet decarbonisation policy targets, on the journey to reaching net zero by 2050.

[20] Project Union Feasibility Phase Reopener (nationalgas.com)
[21] FutureGrid | National Gas
[22] East Coast Hydrogen Delivery Plan - East Coast Hydrogen

5.1.1 Value proposition

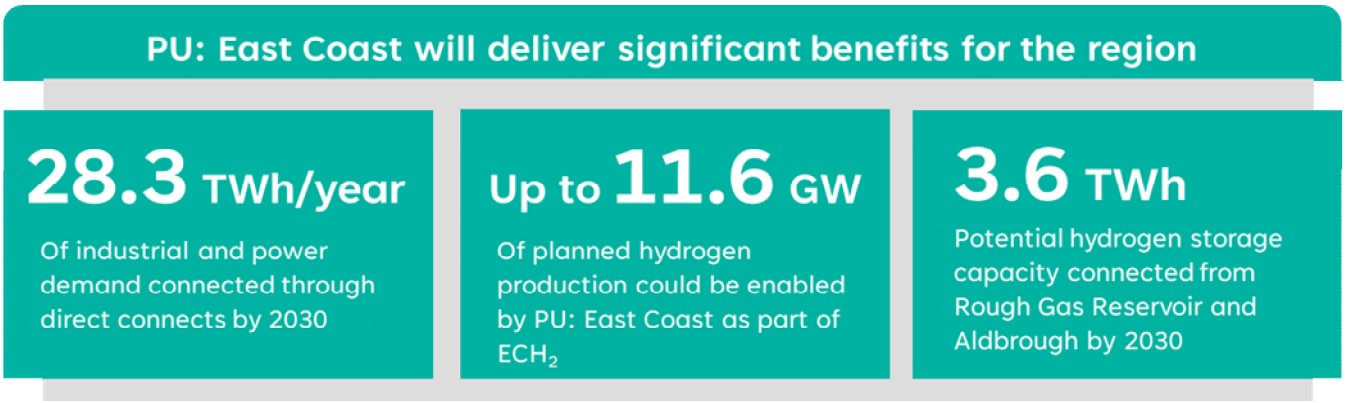
1. **Deliver UK Government commitments:** PU: East Coast aligns to the UK's wider ambition of delivering growth through leading a low carbon hydrogen economy. This will be achieved by tackling the energy needs of the UK's largest industrial clusters, by connecting low carbon hydrogen supply with demand centres. A transmission level connection between, and within, industrial clusters will aid hard to abate sectors and customers, allowing them to achieve their decarbonisation commitments and support the wider UK net zero commitments by 2050.

2. **Create pathway to decarbonise industrial clusters:** Within the East Coast region, natural gas is a primary energy source. Fuel switching to hydrogen, within PU: East Coast, as part of the wider ECH_2 programme, will contribute to savings of up to 7% of the UK's total industrial and commercial (I&C) annual emissions, and over 12% of the UK's total emissions from the power industry.

3. **Provide system resilience and flexibility:** The UK's electricity generation mix has a growing contribution of intermittent renewable power, meaning sufficient storage capacity and low carbon dispatchable power will be required to balance future energy supply and demand. PU: East Coast will deliver this through connecting hydrogen production with demand across the region, to maintain system resilience and security of supply.

4. **Catalyse wider system benefits:** PU: East Coast can provide wider value to the customer through repurposing existing NTS assets to transport hydrogen to end-users, making it more cost efficient for customers and ensures value from existing assets. Repurposing the NTS to carry hydrogen will further support the growth of the local economy by promoting new jobs and maintaining a skilled workforce across the gas supply chain.

5.1.2 Demonstration of need



5.1.2.1 Hydrogen Demand

Hydrogen will play a key role in decarbonising the industrial sector by providing a low carbon feedstock for chemical processes and high temperature heat for industry. Hydrogen will also play a role in decarbonising the power sector, alongside renewables and CCUS, by offering a low or zero carbon flexible alternative to natural gas. Hydrogen is scalable and has the potential for technological maturity which makes it an optimal solution for industry and power decarbonisation.

PU: East Coast will play a prominent role in connecting the future energy system and reducing network constraints through providing power system flexibility, likewise to natural gas which is heavily relied on today.

The region hosts a diverse industrial base with many organisations actively seeking hydrogen conversion to decarbonise operations. NGT's directly connected industries and power station sites have been considered as part of the wider ECH_2 programme stakeholder data collection, establishing over 63 TWh/year of I&C, power and transport hydrogen demand in the region by 2037. The NTS will play a critical role in connecting 27 TWh/year of power demand (hydrogen demand by the power generation sector) by 2030, and 31.1 TWh/year by 2037, by switching some direct natural gas connections to low carbon hydrogen. This is supported by 1.3 TWh/year of directly connected industrial demand (hydrogen demand by the industrial sector) by 2030, and 1.4 TWh/year by 2037. Figure 7, depicts the total hydrogen demand for the region including NGT's industry and power customers and wider I&C and power customers associated with NGN and Cadent.

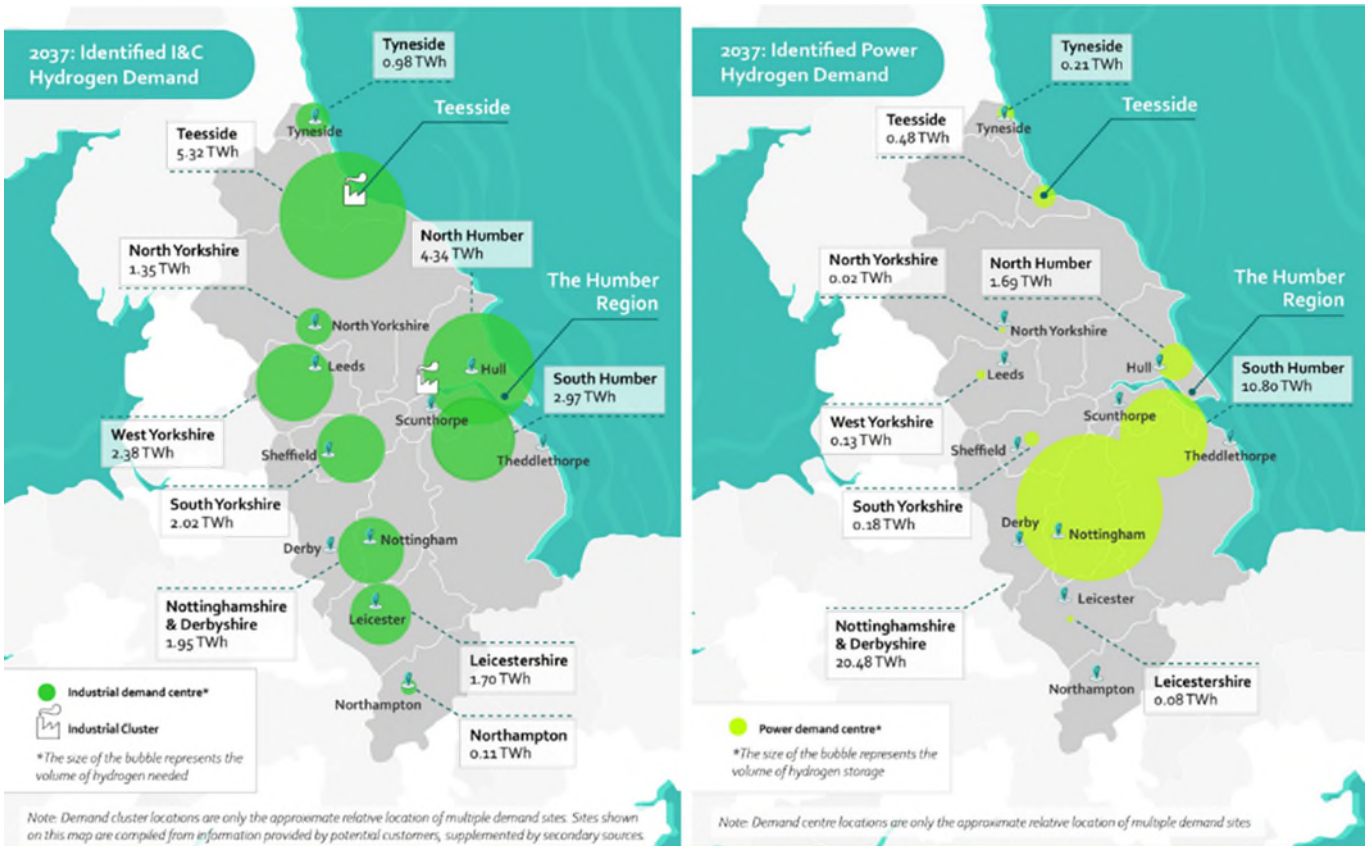


Figure 7 - Total identified I&C and Power hydrogen demand

44% of I&C and power sector sites in the region could fuel switch from natural gas to low-carbon hydrogen by 2037. Over half of these sites are not within close proximity to the industrial clusters and therefore require a transmission system to enable access to production and storage services. PU: East Coast will provide the robust, and integrated, hydrogen network required to facilitate the transmission of hydrogen between these widely dispersed sites. A transmission level connection is required for the efficient distribution of hydrogen from production sites to areas of demand, where otherwise decentralised locations would not have access to hydrogen. PU: East Coast provides accessibility, by creating a connection between demand, production, and storage sites, to ensure that hydrogen is readily available across the region and not just obtainable from those sites in close proximity to production centres. Transmission level infrastructure, proposed through PU: East Coast,

will allow for system resilience between demand sites, while acting as a reserve off taker for hydrogen, where in the absence of such network would otherwise face limited centralised hydrogen supply.

5.1.2.2 Hydrogen Production

As explored in the ECH_2 Delivery Plan[23], considerable amounts of forecast hydrogen production and demand is due to come online quickly, requiring hydrogen transport and storage infrastructure to be developed at pace to prevent network constraints. The East Coast region will host 10.8 GW of planned hydrogen production capacity by 2030 and up to 11.6 GW by 2037, contributing to 58% of the UK's 20 GW of total announced capacity. This will reflect up to 83 TWh/year of hydrogen production capacity by 2037 in the East Coast region. Of significance is the increase in green hydrogen development projects located within the region, and by 2030, 88% of the UK Government target of 5 GW of green hydrogen could be provided within the East Coast region alone. The implementation of PU: East Coast, an integrated transmission system, will connect widely dispersed sites across the region to areas of demand that otherwise would not be accessible. There is also the opportunity for production sites to directly connect to the NTS, providing more widely dispersed areas of demand access to hydrogen.

Key projects are being supported by UK Government investment through funding and revenue support schemes within the East Coast region. Funding has been obtained through the Business Models first electrolytic Hydrogen Allocation Round (HAR1) and CCUS Cluster Sequencing, as well as the Net Zero Hydrogen Fund (NZHF) Strand 1 (Development expenditure - DEVEX) and 2 (Capital expenditure - CAPEX). Projects supported through these funding mechanisms have been able to de-risk investment and reduce lifetime costs.

Through continued customer engagement it is evident that many hydrogen producers are heavily dependent on connecting to a transmission system to allow for flexibility and resilience. Figure 8, illustrates the spread of announced hydrogen production sites in the PU: East Coast region, with five production hubs identifying the need for an integrated hydrogen network connection to distribute hydrogen from these hubs to demand centres.

[23] East Coast Hydrogen Delivery Plan - East Coast Hydrogen

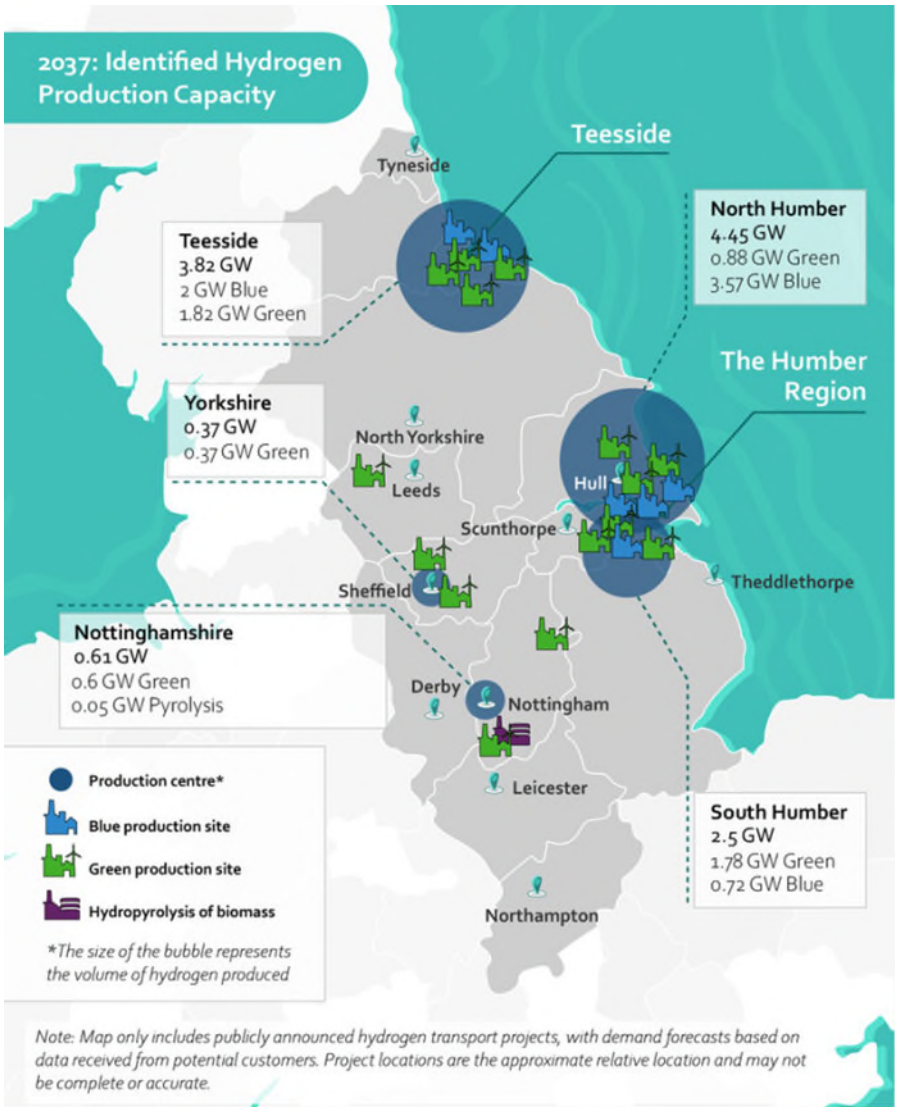


Figure 8 - Total identified hydrogen production capacity by 2037[24]

The overall levels of hydrogen supply are expected to be in excess of the level of demand required by the East Coast region. [redacted] The hydrogen production centres are concentrated on the coast, given the proximity to renewable resources, where demand has a greater regional split into inland centres. The proposed infrastructure would enable effective transport of hydrogen between concentred hydrogen production hubs to demand centres, that otherwise would not be able to obtain the required level of hydrogen supply to decarbonise. Excess hydrogen produced can then be exported to other UK regions, through the wider Project Union backbone. Thus, enabling decarbonisation and ensuring regions with lower hydrogen supply have access to low carbon hydrogen.

[24] East Coast Hydrogen Delivery Plan - East Coast Hydrogen

5.1.2.3 Hydrogen Storage

With the growing contribution of intermittent renewable power in the UK's electricity generation mix, sufficient storage capacity will be required to balance future energy supply and demand. The region hosts a diverse range of planned and potential hydrogen storage, connecting up to 19% of the UK's estimated hydrogen storage requirements by 2050.

To fully realise the whole system benefits of hydrogen, and to provide energy security without unabated natural gas, high levels of hydrogen storage will be required to balance misalignment in hydrogen production and demand at peak and low periods to ensure security of supply to off-takers and producers. Storage locations will also act as a reserve for the use of hydrogen in flexible power production supporting the decarbonisation of the electricity system, whilst allowing production facilities to produce hydrogen when it is most cost-effective and efficient to do so.

The East Coast, with its favourable natural geological features, can be utilised for considerable hydrogen storage. Existing natural gas storage assets and new-build hydrogen storage facilities will ensure system resilience and flexibility within the UK's industrial heartlands. The region also has a prime location to expand off-site hydrogen storage capabilities due to:

1. Availability of existing gas reservoirs and potential salt cavern development for hydrogen storage, with the largest Permian salt field in the UK lying between Humber and Teesside
2. Scale of storage capacity connected, with 3.3 TWh expected from Rough in the early 2030s and a total of 10 TWh by 2050.
3. Potential to unlock further hydrogen storage capacity through the conversion of five existing and planned natural gas storage sites.

Figure 9 shows the 2037 forecasted hydrogen storage capabilities within the region. As hydrogen storage is currently concentrated in the Humber region, demand and production sites in the wider PU: East Coast region will need a transmission level connection to provide access to sufficient storage capabilities. An integrated hydrogen transport system will provide fair access and value to all users in the region regardless of proximity to storage.

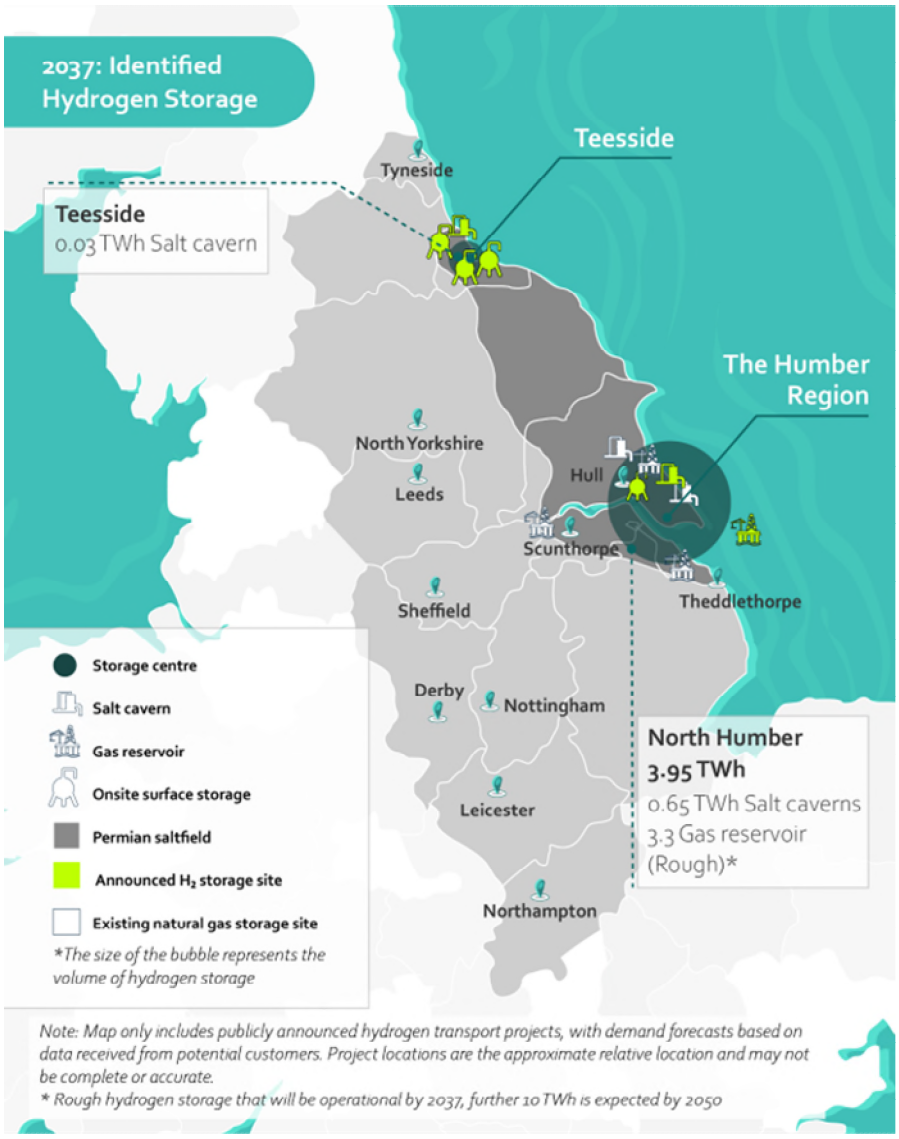


Figure 9 - Total identified hydrogen storage capacity by 2037[25]

5.1.3 ECH$_2$ Programme Benefits

The needs case for PU: East Coast clearly defines the requirement for developing a hydrogen transmission network within the East Coast region, as part of a wider regional roll out of the ECH$_2$ programme. Our transmission level connection, between the Humber and Teesside regions, will provide greater benefits across the region due to the distribution level connection. This provides the opportunity to reach further industrial and commercial sites and enables domestic level decarbonisation.

The industrial cluster connection that we have proposed, provides a direct connection with NGN and within the wider ECH$_2$ region, for Cadent. The potential routing options proposed ensure that demand from the GDNs and their directly connected customers can also be supplied with hydrogen from production centres and storage facilities. The PU: East Coast routing supports NGN to connect 11.4 TWh/year by 2030 and 12 TWh/year of hydrogen demand by 2037. The routing also provides storage options for Cadent via connections at Scunthorpe and Immingham. Further to this, the

[25] East Coast Hydrogen Delivery Plan - East Coast Hydrogen

region will enable the conversion of four potential pilot towns to low carbon hydrogen which could see over 100k residential sites decarbonising their heating by the early 2030s.

The ECH_2 programme is ideally placed to further support the decarbonisation of the transport sector. Hydrogen is a key energy solution for harder to electrify transport, with the East Coast region being home to the first multi-model hydrogen transport hub in the Teesside and pilot projects for freight transport hubs in the Midlands. This will act as a blueprint for regional network conversion to hydrogen, supporting the broader ambitions of Project Union and a UK hydrogen economy.

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[26]

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 phases will be built), taking into account decision criteria (including economic criteria, and criteria relating to wider potential benefits).

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 phase.** 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 phases 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.

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

The review of the assessment suggests decisions regarding the prioritisation of 'gas on' dates for phases 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 phases, where the plans for hydrogen production and demand appear to be more advanced. These phases are likely to be most suitable for early prioritisation for 'gas on'.

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

The distinction of East Coast featuring within Stage 1 of the **MPT** aligns with our proposal to proceed with PU: East Coast 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[27] 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. 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.

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 Benefits to methane network users.

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:

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

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 phase, and we have provided a summary playback of the feedback and our corresponding actions in Appendix B.

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 all directly connected customers were invited to attend as well as dedicated webinars for directly connected customers only.

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 (76% response rate). 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[28]. 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.

6.1.1 Project Union: East Coast Customer and Stakeholder Engagement

Customer engagement has been an integral aspect in the PU: East Coast region, where we have utilised our networks' customer relationships, and the insights provided, to shape our understanding of the areas needs and support further development works such as the ECH_2 programme. ECH_2, of which PU: East Coast forms part of, has been structured with several working groups as to include

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

producers, off-takers and transport and storage developers. The Customer, Stakeholder and Communications working groups have been ensuring that we are effectively engaging with stakeholders across the region. Through this working group, thus far, we have created a consortium formed of 122 members from across the hydrogen value chain, as shown in Figure 10.

To ensure we were developing a network for our customers, we collected hydrogen forecasts for production, demand, and storage capacity from the consortium members, with 180 forecasts provided. Of the [redacted]. From a production perspective, 22 projects have provided hydrogen production forecasts as primary data, as part of the collaborative data collection approach between NGT, Cadent and NGN.

This working group has also managed relations and communications with the consortium group and wider. Three events have been held with the ECH_2 consortium over the last year where we updated stakeholders on the progress of the project and gave the opportunity for consortium members to share lessons learnt in their decarbonisation journeys. A technical integration group, made up of network representatives, supported the delivery of pre-FEED activities, ensuring alignment on methodology and routing options to deliver the most efficient network, which supports all stakeholders in the region.

Figure 10 - Hydrogen value chain ECH_2 consortium members

In November 2023 the East Coast Hydrogen Delivery Plan[29] was launched at the House of Commons. This event was attended by over 120 stakeholders across the hydrogen value chain, local authorities, government, DESNZ and other interested parties. The event highlighted to industry that

[29] East Coast Hydrogen Delivery Plan - East Coast Hydrogen

a hydrogen network is progressing, and to decision makers that there is a need for a network, shown by the industry attendance and contribution to the Delivery Plan.

This has allowed the programme to provide a combined strategic vision for stakeholders in the region to facilitate cross value chain benefits. We have ensured that the programme outputs are consistent with stakeholder needs with a dedicated communications and stakeholder team enforced to drive effective engagement with existing system users and potential hydrogen users. This has allowed us to provide confidence to regional stakeholders regarding hydrogen network infrastructure, allowing them to further invest in hydrogen plans.

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 NGN's hydrogen network development and maintain operability of the methane distribution network, a detailed options assessment (detailed in 7. Options) has been undertaken, where eight options have been identified between Teesside and Humber, including a connection to Theddlethorpe. Customer engagement and data has been instrumental in determining the most appropriate routing options.

6.1.2 Project support

Throughout our engagement with key stakeholders, we have ensured synergy between PU: East Coast and hydrogen projects that other companies are developing within the East Coast region. Frequent bi-lateral conversations, with these stakeholders, has highlighted the considerable widespread support for PU: East Coast 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]

6.1.3 Case Studies

In support of the ECH_2 programme, we reached out to our customers to obtain case studies for the proposed network design, Table 3. For demand and storage, the below case studies reflect sites currently directly connected to the NTS whereas for production, these case studies outline the potential capabilities of the region. The below narrative has been directly provided via the customer, as part of the ECH_2 programme, with further case studies for the East Coast region within the East Coast Hydrogen Delivery Plan.

Demand	
West Burton Energy West Burton is committed to decarbonising its power stations so it can continue to provide flexible and efficient energy to the grid. It is currently exploring how it can convert its Combined Cycle Gas Turbines (CCGT) to run on a blend of hydrogen and natural gas. ***"ECH$_2$ could support the West Burton decarbonisation strategy by enabling the development of the critical infrastructure needed to supply hydrogen at scale to the West Burton plant."*** - Heather Wilkinson, Growth and Strategy Manager	**Keadby Hydrogen Power Station** SSE Thermal and Equinor are developing Keadby Hydrogen Power Station, which would have a peak demand of 1,800 MW of hydrogen, producing zero carbon emissions at the point of combustion. It would be the world's first major 100% hydrogen-fired power station, securing at scale demand for hydrogen in the region for decades to come. With appropriate policy mechanisms in place, Keadby Hydrogen could come online before the end of the decade. In order to bring forward hydrogen to power projects, a hydrogen network will be essential. That is why ECH$_2$ has an important role to play in the development of a thriving hydrogen economy in the region, allowing sites to connect with a wider network carrying the fuel to centres of demand. That will be vital not only for Keadby Hydrogen but also for other hydrogen to power projects in the Humber and beyond
Storage	
Aldbrough Aldbrough Hydrogen Storage facility is looking to convert existing natural gas storage in salt caverns for hydrogen storage. It is expected to be in operation by early 2028, subject to positive policy developments and consents being given, with an initial capacity of at least 320 GWh, which is enough to power over 860 hydrogen buses a year. This project offers future storage opportunities for hydrogen produced at multiple sites across the Humber cluster, with close proximity to Hornsea 2 offshore wind providing renewable power for Green Hydrogen production.	**Rough** Rough's unique geological and geographical advantages position it well to support a growing hydrogen economy and with no insurmountable technical barriers to conversion, it could store 10 TWh of hydrogen, 94% of announced storage capacity, making it one of the world's largest hydrogen stores. **"Our long-term aim remains to turn the Rough field into the world's biggest natural gas and hydrogen storage facility, bolstering the UK's energy security, delivering a Net-Zero electricity system by 2035, decarbonising the UK's Industrial Clusters, such as the Humber region by 2040, and helping the UK economy by returning to being a net exporter of energy"** - Chris O'Shea, Centrica CEO.
Production	
Equinor Part of Zero Carbon Humber, H2H Saltend will be led by Equinor. By using Humber's unique geography to deploy and grow hydrogen and CCS, this will help to deliver one of the world's first large low carbon Industrial Clusters by 2040. A first-of-a-kind 600 MW Blue Hydrogen production plant will enable fuel switching at scale by 2026/7, providing 6% of the UK's hydrogen production target. ***"ECH$_2$ can enable early developing Hydrogen Transport and Storage Infrastructure, as well as both CCS enabled and electrolytic hydrogen production to be connected to the wider East Coast region, thereby consolidating and aggregating demand and accelerating the development of the Hydrogen Economy"*** - Ian Livingston, Project Manager.	**Uniper** The Humber H2ub® project is a proposed large scale, low carbon hydrogen production facility at Uniper's Killingholme site, being delivered by Uniper in partnership with Shell. The project is expected to be operational later this decade. With plans for low carbon hydrogen production capability with a capacity of up to 720 MW, the Humber H2ub® could contribute to the UK Government production target of delivering 10 GW of hydrogen by 2030.

Table 3 - PU: East Coast case studies

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 stakeholder engagement 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 • Support engagement with OEMs to build H2 readiness and transition plans • Identification of delivery of new collaboration opportunities	• Continued direct connect quarterly bi-laterals • 1-1 meetings • Request for Information (RFI)
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	• Cadent Gas • Northern Gas Network (regional interface)	• 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	• East Coast Hydrogen Consortium (122 members) • Humber Freeport • East Midlands Freeport Zone • The Northern Endurance Partnership • East Coast Cluster • Zero Carbon Humber (15 formal partners)	• 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
Local Government	• East of England Local Government Association • D2N2 LEP (East Midlands) • Greater Lincolnshire LEP • Net zero Tees Valley / Tees Valley Hydrogen Hub (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)	• 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, Historic England, Environment Agency) • Planning Inspectorate (PINS) • DESNZ • The public/ affected communities	• Progress relationships • Raise project awareness • Feedback on routing and survey requirements and scope • Guidance / clarity on consenting hydrogen projects • Feedback on Consultation Strategy • Feedback on routes /impacts to shape the project	• 1-1 Meetings and project and topic workshops (likely to need Planning Performance Agreement for Local Planning Authorities (LPAs) and use of Discretionary Advice Service for statutory bodies) • Environmental Impact Assessment (EIA) Screening and Scoping requests • Consultation material – e.g., website • Public consultation

Table 4 - FEED Engagement Plan

6.4 Whole Systems 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[30] and Guidehouse[31] 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.

[30] Benefits of long-duration electricity storage (afry.com)
[31] Gas and Electricity Transmission Infrastructure Outlook 2050 (guidehouse.com)

- The CCC[32] 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[33] 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[34] 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.

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, 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.

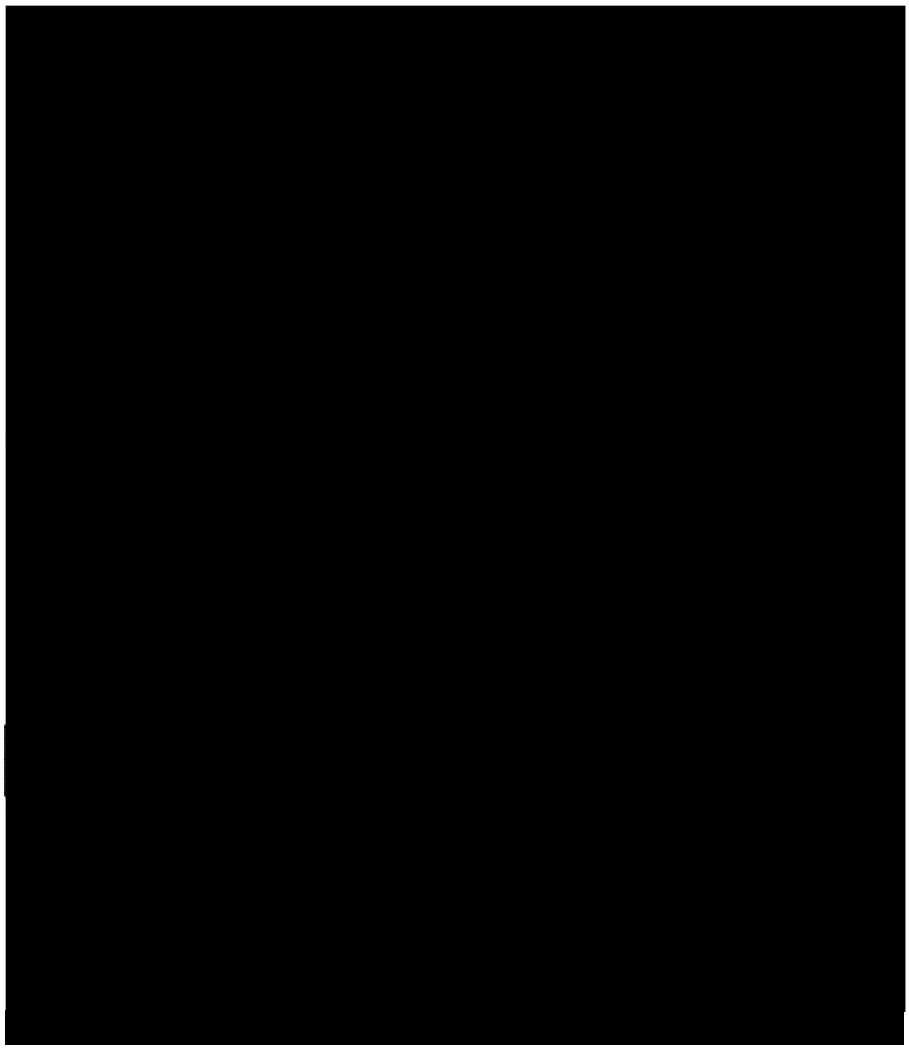
[32] Delivering a reliable decarbonised power system - Climate Change Committee (theccc.org.uk)
[33] Net Zero Strategy: Build Back Greener - GOV.UK (www.gov.uk)
[34] UK hydrogen strategy - GOV.UK (www.gov.uk)

7. Options

The NTS is at the heart of UK 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]



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. Finally we concentrate on exactly where a new connection might run, consulting local communities and others, to minimise any impacts on local people and the environment.

Project Union: East Coast 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, the consideration of repurposing pipelines was a priority over new build pipelines due to the cost, time and environmental benefits associated with repurposing. Further detail on this approach can be found in 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. 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 the established needs case for hydrogen transmission infrastructure. 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
- 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 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, production, and storage located within the East Coast region:

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

7.1.2 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. The network analysis was carried out in two parts.

[redacted]

[redacted]

[redacted]

[redacted]

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 Decision Support Tool (DST), a tool developed [redacted] in line with guidance from PIE[35]. [redacted]

[redacted]

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

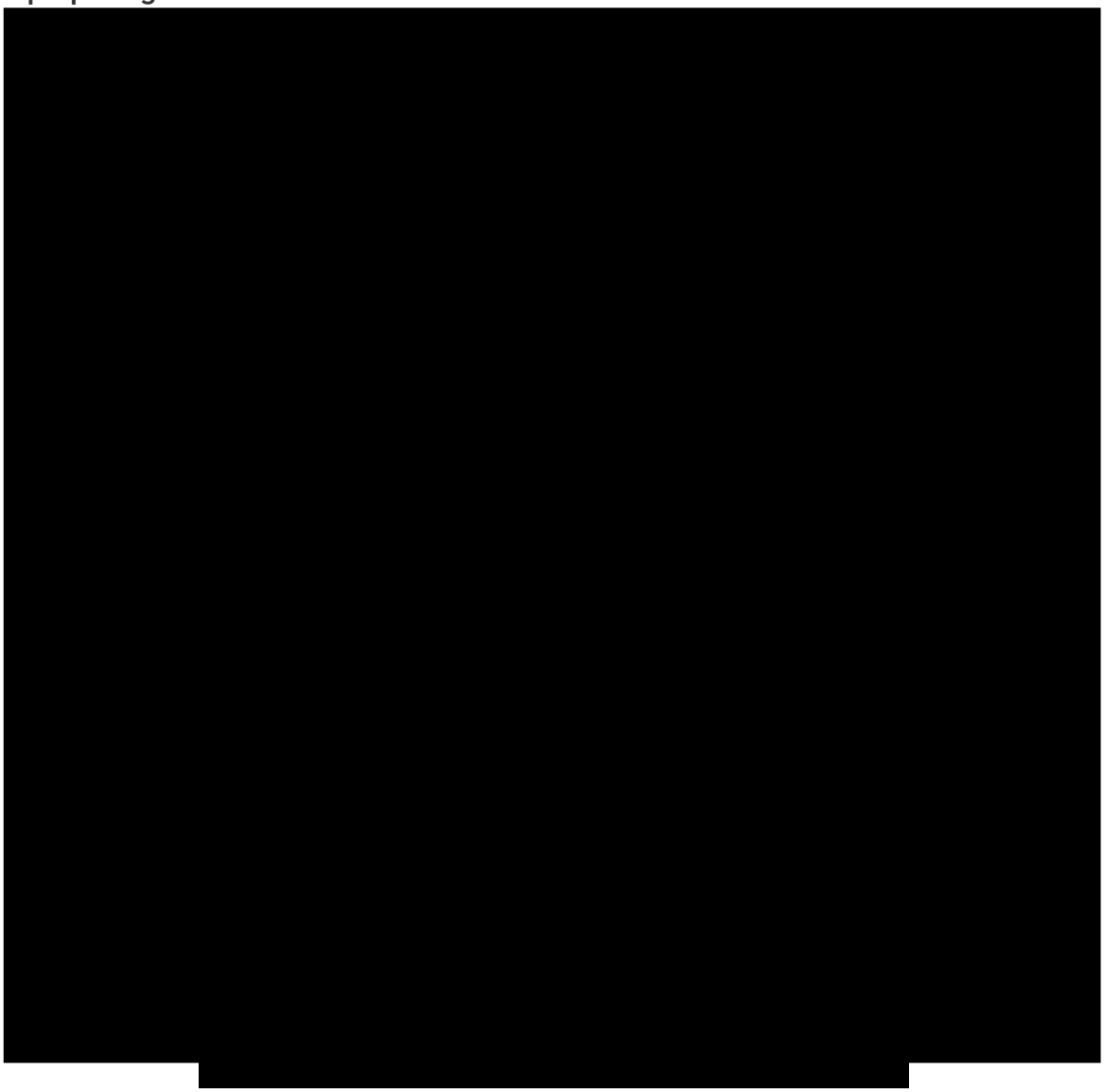
The six criteria the DST used to assess the risk of repurposing an existing methane pipeline to a hydrogen service were: Material Grade, Design Factor, Hydrostatic Pressure, Hydrogen Maximum Operating Pressure (H2 MOP), Fracture Toughness, Defects and Metallurgy Issues. A lower final assessment score from the DST represents a lower risk of repurposing.

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: East Coast 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 FEED stage.

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.

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, .

7.2 Hybrid Strategic Options

The appraisal's primary objective was to evaluate the technical feasibility of repurposing existing assets where possible. [redacted] this has resulted in an incomplete network with gaps between the available repurposed sections; we would term this as a 'non-contiguous' network. Therefore, strategic options need to be considered on how to achieve the primary objectives of creating a contiguous UK hydrogen backbone that connects national strategic areas. This will result in a pipeline route consisting partially of repurposed pipeline and partially an alternative solution. We have termed this as a 'Hybrid' layout, and thus the Strategic Options developed under this theme have been termed 'Hybrid Options'. The below illustrates the pipelines that are being considered for repurposing, the "gap" in the network between repurposing candidate Feeders, and strategic connection points, across demand, production, and storage within the East Coast.

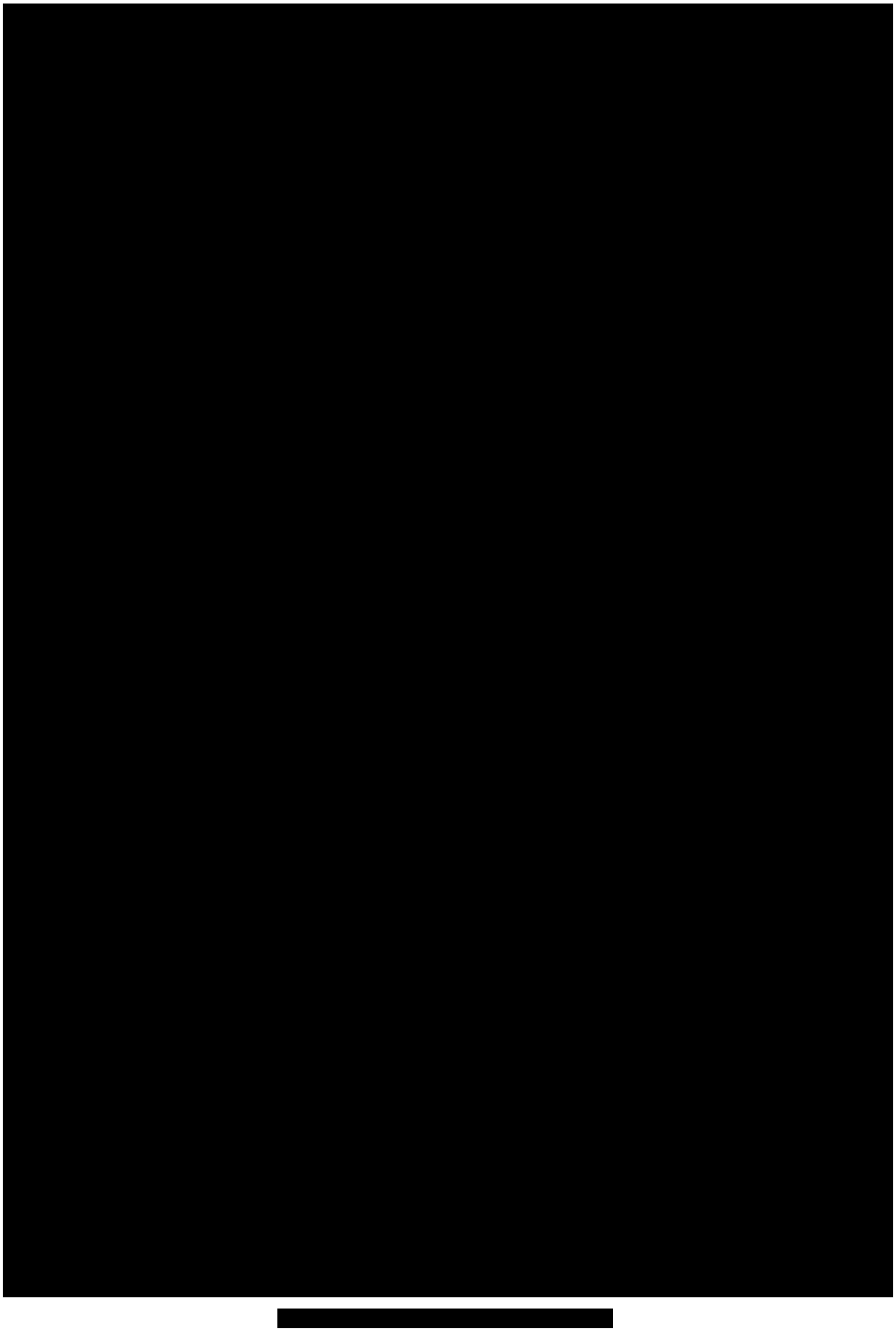
[redacted]

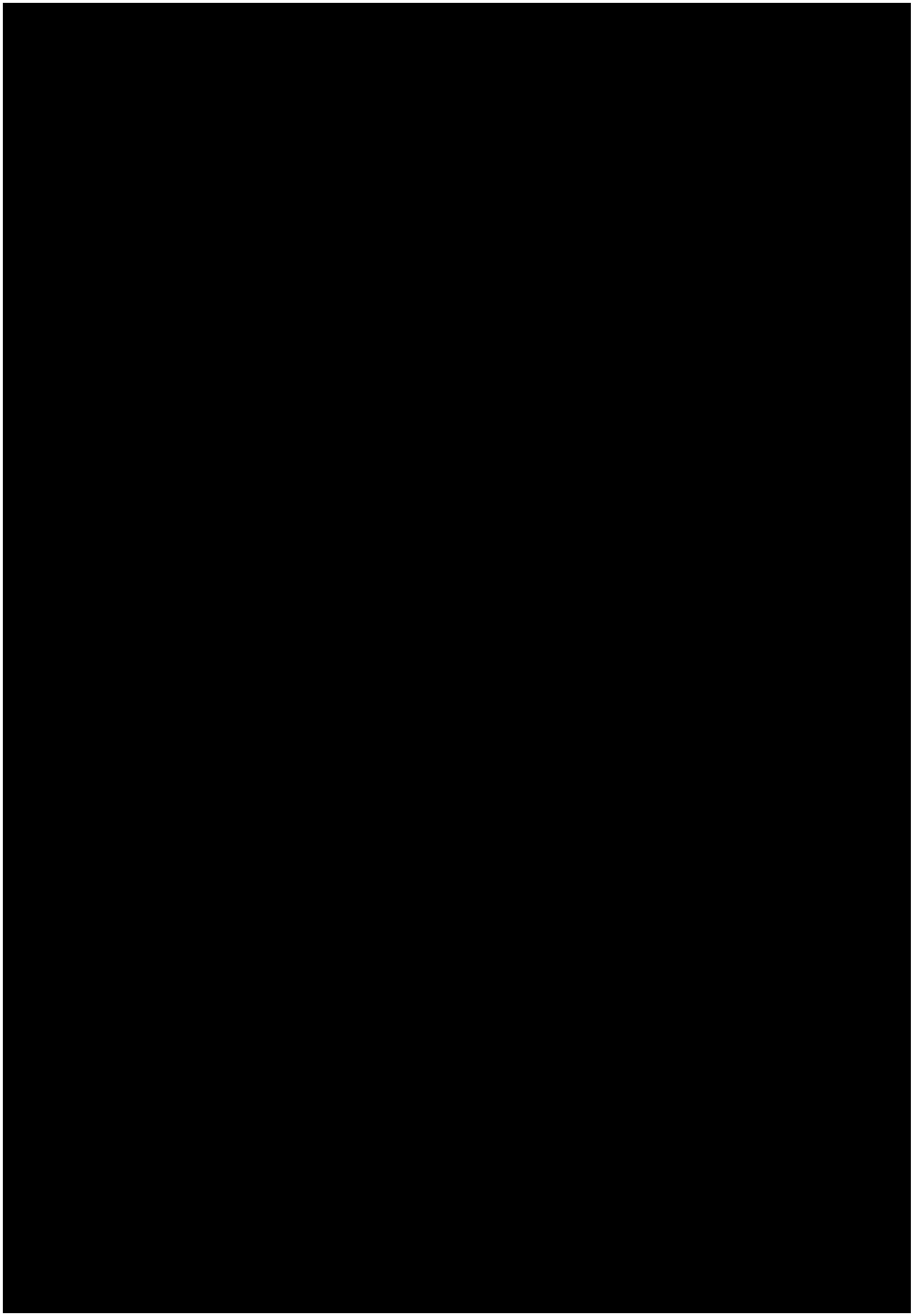
7.2.1 Hybrid Strategic Options Long list

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 East Coast 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.

A long list of 13 options, [redacted] were developed which included a range of pipeline solutions to achieve the strategic objectives. Non-pipeline hydrogen transport options (shipping, road transport etc.) were also considered in the long list. The long list was assessed against the weighted criteria detailed in Table.

[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 East Coast 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.
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.
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 8- Criteria Description and Weighting

[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 futures connections as they limit the ability for new customers to connect to the network.
- The options that ranked the highest were onshore pipelines that created a continuous network and connected into storage locations in the North Humber area.

7.2.2 Preferred Hybrid option

Hybrid K is the preferred strategic option for Project Union: East Coast which ranked the highest in the criteria assessment. Option Hybrid K achieves two major Project Union objectives of connecting

to [redacted] Hybrid K also scored higher in both the Known Customer need and future connections criteria as it has pipeline routing that passes via the most known existing customers and supports the plans of NGN.

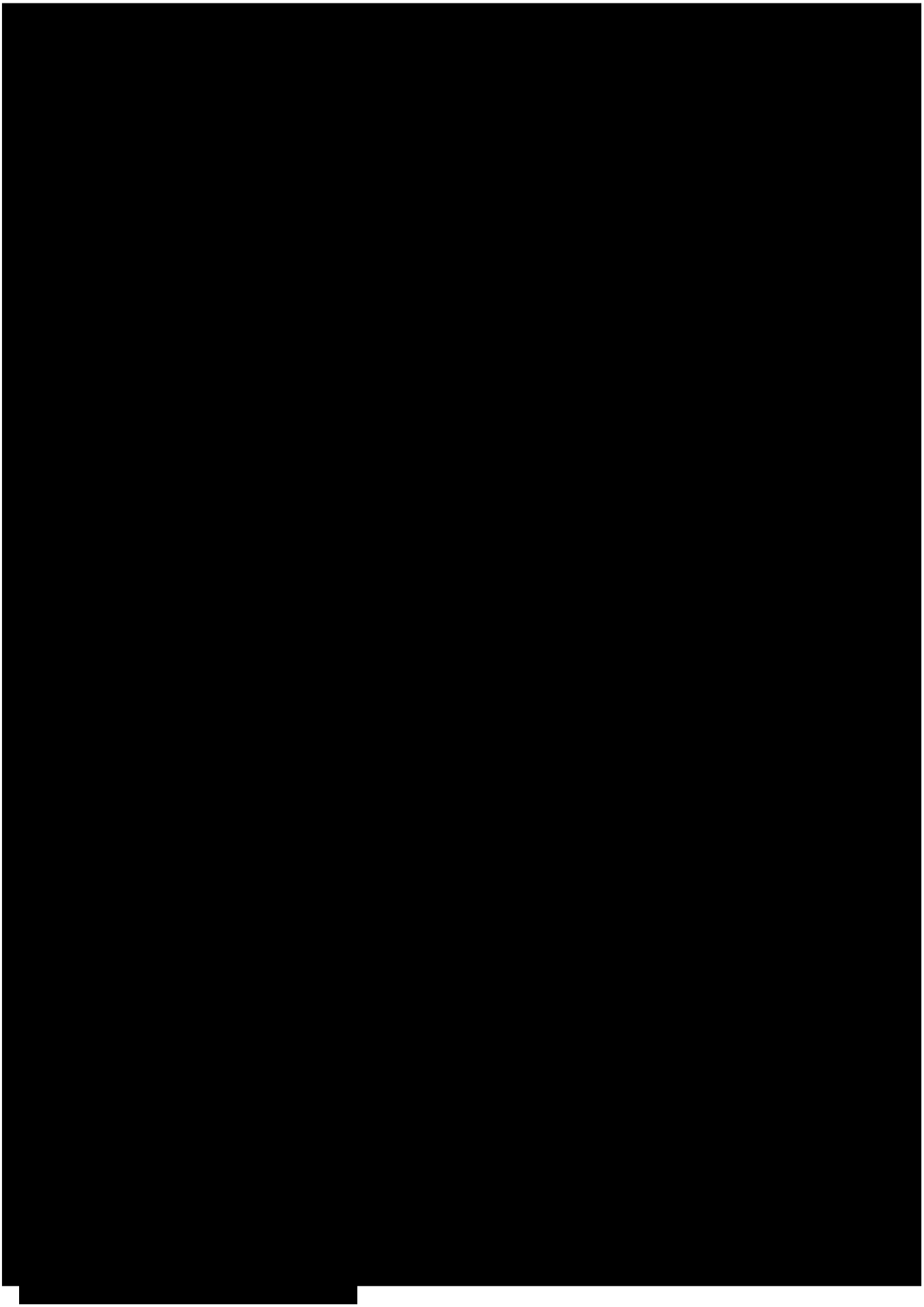
To develop the indicative route corridors for hybrid K a multi criteria analysis (MCA) was completed to determine the least constrained path between repurposed pipelines and strategic connection points.

A core option was established that connected all the strategic location points, Hybrid K.0, and variations of this option, Hybrid K.1- K.4, present options with major spurs removed and variations in repurposed feeders. [redacted] A bottom-up cost model, covering project development from FEED through to commissioning, was made to assess the core options and variations. [redacted] A cost benefit analysis was conducted on these variations and baselined against a full new build option. This is detailed later in the options chapter.

[redacted]

[redacted]

[redacted]



7.3 Full New Build Strategic Options

As described earlier in this section, repurposing pipelines is preferred over new build pipelines due to the cost, time and environmental benefits associated with repurposing. However, 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 East Coast region. In order to mitigate this risk, initial high-level optioneering has been conducted to consider the technical feasibility and potential cost of a full new build option and provide data on which to base a credible bottom-up FEED cost estimate.

7.3.1 Full New Build Strategic Options Long list

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]

[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 these best aligned with primary Project Union strategies and the customer needs cases identified through direct engagement and the East Coast Hydrogen project.
- Strategic New Build Option E and F tended towards similar positive scores due to the location of existing industrial and DN demands being broadly aligned to the existing NTS corridors. This naturally tends to result in new pipeline routes following similar corridors. Furthermore, the concept of parallelism also scored highly as it provides greater opportunity for a smoother transition for directly connected NTS customers and could result in additional natural locations to implement hydrogen blending into the wider NTS. As such, New Build option E and F were considered to be strategically similar options. New Build option E was shortlisted for further assessment. By taking this approach the MCA routing software could be used to assess if there were less constrained paths to connect the strategic connection points than the existing NTS routes, based on current land and environmental designations, which are likely to have changed since the NTS was constructed.

7.3.2 Full New Build Shortlisted Options

Two variations on an MCA were performed on the shortlisted strategic option New Build E to determine the least constrained path between the national strategic locations and the strategic connections points. 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]

[redacted]

[redacted]

7.4 Cost Benefit Analysis (CBA)

The cost benefit analysis was completed to assess the benefits that each option provides to consumers.

- The constraints from the impact on the methane network capability when removing feeders from the network for repurposing was considered for 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 6. Stakeholder Engagement and Whole System Opportunities.

- The counterfactual considered was a full new build option for the hydrogen transmission network in PU: East Coast. Alternatives to a transmission network were considered (shipping and road tankers) as part of the Feasibility phase however ruled out as a cost-efficient option to take forward. 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]

Due to the same 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]

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

Following the appraisal process, two preferred options will be taken forward for further development:

- [redacted]

Both options achieve the project objectives of connection of two of the largest industrial clusters in the UK, Humber and Teesside, while connecting these clusters with hydrogen production, storage and demand sites in the broader East Coast region.

The Hybrid and New Build options will be developed in parallel during the early part of FEED until such time as re-purposing can be confirmed. At this point development of the new build option would stop. This approach will minimise any impact on the project timeline should the repurposing option be ruled out.

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. This incorporates FEED for the East Coast region, as well as PU: Essential Enabling Activities that are required for the delivery of FEED and to ensure a fully operational network.

8.1 Aims and objectives for PU: East Coast

PU: East Coast will not only deliver FEED for the East Coast region but also PU: Essential Enabling Activities over a 24-month period. The broad outcomes of this phase are to:

- 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 East Coast region.
- Demonstrate how new evidence has been adopted to further refine the social economic assessment and phasing strategy for the full UK hydrogen backbone.
- Develop options for the design of commercial frameworks, while continuing to undertake customer and stakeholder engagement.

The purpose of PU: East Coast will be to complete a robust technical and economic assessment for preferred routing corridors in the East Coast region. This will be delivered alongside the continuing development of an overall transition plan for delivery of a full UK hydrogen backbone, aligned with industrial cluster developments, policy and customer and stakeholder needs. This will involve the collaborative delivery of work packages across East Coast FEED and PU: Essential Enabling Activities.

As part of **East Coast FEED** developed work packages, we will:

- Investigate the preferred technical options for routing within the East Coast region, linking concentrated hydrogen production hubs with demand centres and storage sites.
- Deliver conceptual design for PU: East Coast, together with a construction programme and cost estimates for subsequent phases for PU: East Coast.
- Ensure the project maintains continuity and progress while developing a contracting and procurement model that ensures value for money.
- 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 East Coast route options and enable project delivery within programme timelines, non-statutory consultation, including DCO pre-application support.
- Complete the required environmental surveys, and Formal Environment Assessment (FEA) proforma required to comply with environmental consents for East Coast route corridor.
- Collect and assess robust asset integrity information to ensure pipeline readiness for hydrogen transportation and support optioneering of sections to be repurposed.

As part of **PU: Essential Enabling Activities** developed work packages, we will:

- Ensure timely and successful delivery of the overall programme plan, in conjunction with consolidated reporting and financial management.
- Further develop the needs case, phasing strategy and social economic assessment in response to new evidence and ongoing development of the hydrogen economy.
- Review and assess, ongoing UK and EU policy development to ensure alignment and integration with Project Union.
- Define operating procedures, physical and commercial mechanisms, emergency arrangements as well as IT systems and facilities required to operate a hydrogen backbone.
- Refine network modelling assessment aiming to demonstrate the potential to repurpose elements of the existing NTS, and the optimisation of new build options ensuring the most cost-effective option.
- Develop a plan, risk assessment and cost estimates for construction implications.
- Implement the governance structure and framework defined in the Feasibility phase to begin delivery of hydrogen specific technical standards to ensure the safe design, construction, commissioning, operation and maintenance of a hydrogen backbone.
- Gather, collate and analyse critical data specification to inform decisions on future hydrogen network development.
- Adapt existing methane Asset Management Plans (AMPs) around Project Union requirements in tandem with the development of an overarching Hydrogen Asset Management strategy and capabilities.
- Understand the needs of a future hydrogen workforce, identifying the gaps that exist today and the work needed to fill these by the time these skills are required.

8.2 Formulation of Scope

Ofgem's guidance[36] 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 20. 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.

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

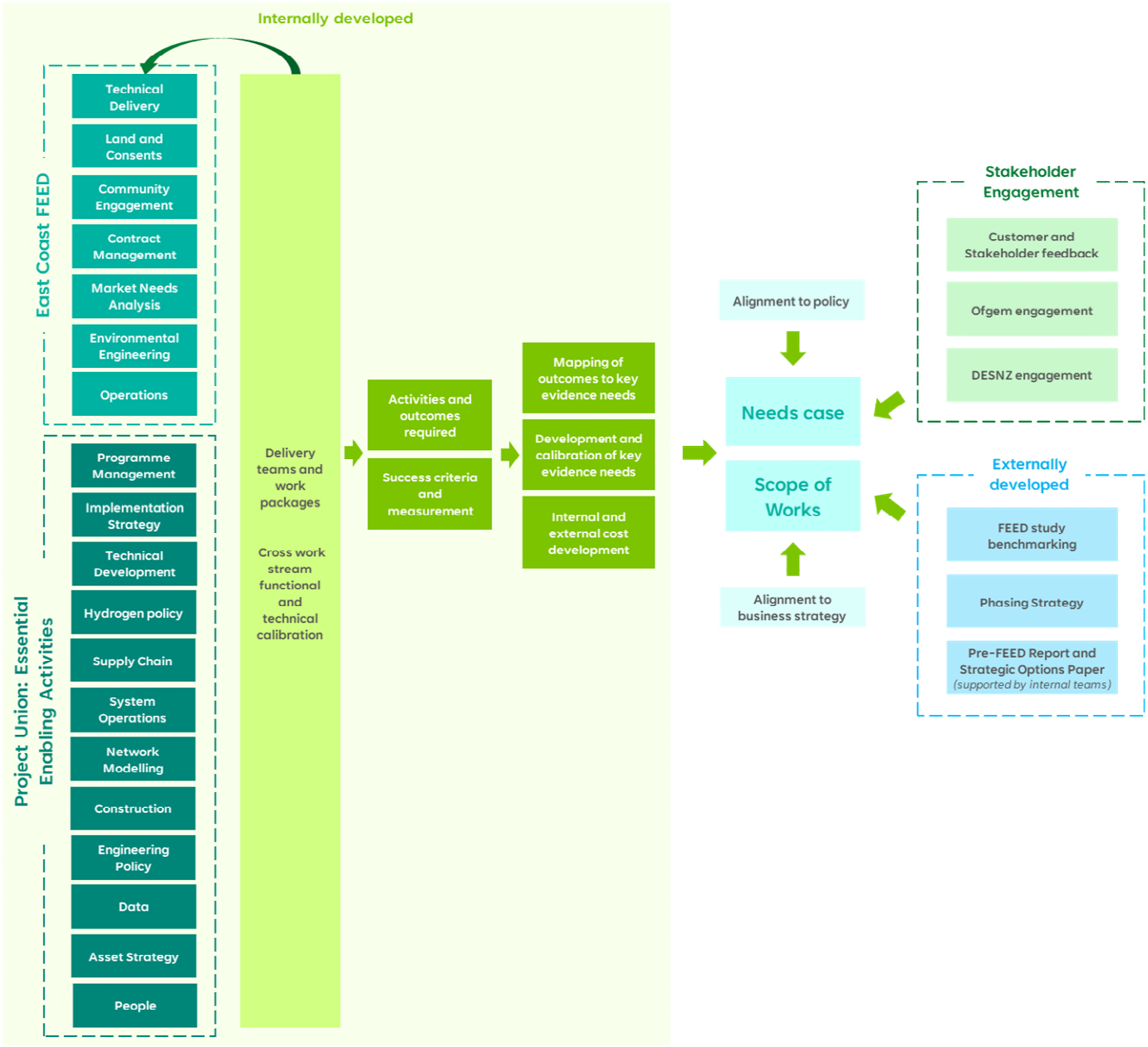


Figure 20 - Approach to Needs Case and Scope Development

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 East Coast FEED work packages, outcomes, and success criteria

Over a 24-month period the programme will deliver FEED for the East Coast 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]

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 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 '*'.

Key Outcomes	Success criteria
Delivery of FEED Studies including conceptual design, engineering assurance, environmental & ecological studies, and operational readiness information.	• Conceptual design for PU: East Coast 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: East Coast; 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*
  - 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 14 - 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: East Coast 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.

Outcome	Success criteria
Secure all necessary legal rights on / over land	• Compliant with chosen planning regime and statutory deadlines • 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 documentation	• Completion of land referencing and land interest questionnaires • Preparation of DCO 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	• High quality route corridor report which has considered all options which will form the basis of public consultation and further stakeholder engagement

possible) Updated Land & Consents Strategy for preferred option	
EIA Screening and Scoping	• 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	• Completion of PEIR for DCO and supporting 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 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

Table 15 - 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: East Coast. 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: East Coast. 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	• 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: East Coast, identification of interested (or disengaged parties) and opportunities

awareness and understanding of PU: East Coast plans, impact on existing infrastructure, potential issues, interactions, and challenges to be considered and managed.	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: East Coast; 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) • Collation of information about PU: East Coast 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: East Coast

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

Table 16 - 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 East Coast specific procurement requirements and market engagement. These activities will ensure the successful appointment of partners to support PU: East Coast (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: East Coast FEED section

Key Deliverables
• FEED contract awarded for PU: East Coast

Table 17 - 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 East Coast 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: East Coast 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: East Coast • 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 18 - 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: East Coast 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: East Coast design requirements

Key Deliverables
• FEA proforma populated and managed to completion for PU: East Coast FEED

Table 19 - 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: East Coast 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 20 - Operations Key Outcomes, Success Criteria and Deliverables

8.2.2 PU: Essential Enabling Activities work packages, outcomes and success criteria

Over a 24-month period the programme will also deliver PU: Essential Enabling Activities required for the delivery of FEED to ensure a fully operational network, as well as activities supporting the delivery of further phases of Project Union. Successful completion of this will involve delivering the work outlined within the PU: Essential Enabling Activities work packages explored below. This section outlines the scope of the ten work packages identified, including the specific outcomes, and associated assessment criteria for each. These work packages form a foundation for FEED and Project Union and will require growth and build out in future phases of Project Union.

Programme Management

The Programme Management work package was funded in the previous Feasibility Re-opener and will continue to support this next phase of work operating as a central hub to drive project delivery. It will continue to embed project management processes and be accountable for driving adherence to programme, outcomes, and cost. The work package will perform assurance for the project and provide consolidated reporting and financial management. The team will take ownership for the Re-opener closure report which was a key deliverable requested by Ofgem as part of the last consultation. In addition, financial management, regulatory support and recruitment support will be delivered as part of this work package. Whist working on PU: Essential Enabling Activities for all sections, this work package will be critical to progress FEED.

Key Outcomes	Success criteria
Continuation of overarching Project Union Programme Management activities commenced in the Feasibility phase and delivery of the overall Programme plan for this current phase of work	• Programme Management standards and governance • Adherence to Programme, outcomes, and cost • Provision of Programme assurance • Provision of consolidated reporting • Drive and support development of work package inputs, governance, milestones, and products • Completion & lessons learned from FEED Phase Re-opener
Financial Management and Regulatory support	• Assurance and independent expert review • Compliance guidance and management of changing regulatory frameworks and mechanisms. • Project Union specific engagement with regulator • Financial reporting and budget management
Resourcing support	• Defined target candidate profiles and proactive talent searches • Social attraction and company awareness • Employee referral programme • Collaboration with universities and research institutions • Continuous evaluation and optimisation of recruitment strategies

Key Deliverables
• Detailed Delivery Plan covering the overarching elements of the programme and updated for each section as Re-openers are submitted • Re-opener Closure Report

Table 21 - Programme Management Key Outcomes, Success Criteria and Deliverables

Implementation Strategy

The Implementation Strategy work package was funded in the previous Re-opener and will continue to provide overall integration and alignment into the project for non-technical and wider work packages. It will be responsible for any future funding submissions for design and construction, as well as look to further develop the phasing strategy based on new evidence gained through the wider hydrogen programme. In addition, the work package will provide ongoing development of the needs case for Project Union and continued assessment of the benefits it brings to UK and globally.

Key Outcomes	Success criteria
Submission of funding request documents for next phase of Project Union (Re-opener / HTBM applications)	• Development of non-technical scope for next phase of Project Union • Development of funding submission for Ofgem / DESNZ • Integration with wider hydrogen projects within NGT • Overall integration (technical, non-technical and wider work packages)
Continued development of the phasing strategy and social economic assessment created in the Feasibility phase of Project Union to incorporate FEED phase of work	• Long term delivery plan for Project Union developed out to construction, aligned with inputs from innovation projects and regional groups • Delivery of Economic Analysis and CBA to support funding decision and continued assessment of the benefits of a hydrogen backbone

Key Deliverables
• Updated Phasing Strategy • Updated Economic Assessment • Needs Case Triggers and funding applications for the subsequent phases of Project Union

Table 22 - Implementation Strategy Key Outcomes, Success Criteria and Deliverables

Technical Development

The Technical Development work package will be responsible for the development and coordination of specialist technical activities required to support and inform the Technical Delivery workstream. These work packages relate to both high level network design (for example, pipeline routing,

customer technical requirements, requirement for compression) and specialist technical information required to support design activities.

The pre-FEED has identified a number of existing NTS Feeders that are candidates for repurposing for hydrogen. The Technical Development work package will continue the process of identifying the need for, prioritising and scheduling asset inspections, in addition to instructing and co-ordinating any subsequent testing and validation work as necessary. This is a critical activity to validate that NTS Feeders can be safely repurposed for use with hydrogen.

A core concept in the planning process is the continuing back check and development of the pipeline route options as the project progresses and more information becomes available (for example, more detailed technical information, feedback from stakeholders etc.). The Technical Development work package will use specialist GIS routing tools to continue to develop and assess route options to inform the Technical Delivery work package.

Customer technical requirements will inform and influence the design of the PU: East Coast network. The Technical Delivery work package will lead technical interaction with customers. This will be critical to, for example, understanding the need for compression.

The work package will also provide alignment with wider innovation work packages and deliver specifications for network and asset design that are required by the Technical Delivery work package. Whist working on PU: Essential Enabling Activities for all sections, this work package will be critical to progress FEED.

Key Outcomes	Success criteria
Validation of suitability of NTS pipelines for conversion to transporting Hydrogen	• Identification of appropriate pipeline sections on the PU: East Coast route for deploying novel inspection tools for hydrogen readiness • Analysis of the collected integrity data, alongside Business as Usual (BAU) data, to provide a technical summary of the pipeline sections readiness for Hydrogen conversion
Development and coordination of the required specialist technical work packages to support FEED to ensure robust technical assessment and optioneering of the remaining options from the Feasibility phase	• Integration of other technical workstreams (e.g. innovation) into technical optioneering • Technical support to customers to ensure customer requirements are understood and incorporated into network design evolution • Ongoing back check and validation that pipeline designs achieve project aims • Validation of the need for compression and high-level specification of compression design

Key Deliverables
• Technical summary of pipeline sections readiness for hydrogen conversion • Customer technical requirements identified and incorporated into network design • Validated network design including compression as required • Back check and review of pipeline route options to support design and consenting activities • Finalised route option to take forward to Detailed design

Table 23 - Technical Development Key Outcomes, Success Criteria and Deliverables

Hydrogen Policy

The development of the hydrogen market and the enabling network, Project Union, is underpinned by energy policy and the legislative framework. The development of energy policy and the supporting legislative framework will be key to the development of Project Union.

The aim is to ensure evidence is provided to UK policy makers for policy decision making and understand the impact of policy to support the development of Project Union. This evidence will support the ongoing assessment and development of energy policy, with the aim of gaining a better understanding of the impact of international energy policies, assessing the ongoing development of European energy policy and how this links with UK energy and hydrogen policy and the development of the UK hydrogen backbone.

Key Outcomes	Success criteria
Collate information on international hydrogen policies and how this helps progress the development of a hydrogen transportation network	• Gain an understanding of the impact of energy policy on hydrogen developments and their impact on the ongoing development of Project Union

Key Deliverables
• Report outlining EU and some European hydrogen policies and their anticipated impact.

Table 24 - Hydrogen Policy Key Outcomes, Success Criteria and Deliverables

Supply Chain

During the Feasibility phase the Supply Chain work package delivered the Supply Chain Assessment deliverable, a key piece of work that will inform PU: East Coast FEED. The Supply Chain work package will continue to focus on supply chain, procurement and contracting strategy as pivotal activities to ensure the successful appointment of partners to support PU: East Coast (cost, time, and quality). The macro-economic environment for construction is growing due to large scale infrastructure projects in the UK and globally. Our formal contracting strategy will consider market feedback, construction market trends to ensure we get a resilient and fit for purpose supply chain to deliver on these works.

Key Outcomes	Success criteria
Development of contracting and procurement model for delivery of all sections of Project Union across new pipeline, repurposing, compression, products and construction services	• Finalisation of enduring contract/procurement strategy to enable award of work packages. Success hinges on creating; Resilient contracting structure which has correct capacity, collaborative approach, Value for money driven decisions, Programme adherence
Support FEED Framework and other enabling services, ensuring continuity of the project and progress whilst overarching procurement strategy for later phases is finalised.	• Effective procurement processes utilised to award contracts under Utility Contract Regulations (UCR) • Requirement for increased volume of buying support across all disciplines needed for Project Union

Key Deliverables
• Contracting and Procurement Model • Contracting and procurement required for all construction services and FEED stages • Plan of any required services for the Programme-Incorporated into the delivery plan

Table 25 - Supply Chain Key Outcomes, Success Criteria and Deliverables

System Operations

"How would a System Operator operate a 100% hydrogen network throughout the different phases of Project Union?" is the problem statement this work package will answer.

The System Operations work package will provide a mapped-out model for the future system operation of the 100% hydrogen network and its evolution through the phases of Project Union. Specifically, to understand in more detail, the phases of the hydrogen transition; to provide a comprehensive outline of the physical and commercial mechanisms, tools and processes needed for each of the roll-out phases of Project Union; to provide costed preferred options for the physical and legal implementation.

To deliver this we will need significant engagement with industry stakeholders, to evaluate a range of options and to evaluate the costs and benefits of different approaches to operating the Project Union 100% hydrogen network. This will ensure, that subject to approval, work to deliver and implement the system operator activities will be ready to begin in 2026 alongside the start of the physical asset works.

By not doing this work we run the risk that we reach an impasse, where assets are ready to transport 100% hydrogen, but the operational rules and tools are not in place, meaning we cannot operate those assets.

Outcome	Success criteria
Hydrogen transition progress: Coupling of the Common Planning Pathways with expected policy developments to map the expected progress of the physical hydrogen transition	• Define scenarios of hydrogen supply and demand, networks and storage through the phases of the hydrogen transition by economic and technical experts • Analysed drivers for change and development of roles and responsibilities within the hydrogen value chain. The output of this work will enable better understanding of the progress of the phases of the hydrogen transition, facilitating the subsequent work areas

Physical and Commercial Operation: Establish and document the mechanisms required for the physical and commercial operation of the hydrogen network throughout the phases of Project Union	• Develop preferred physical and commercial operating regimes for the 100% hydrogen network and its stages of maturity
	• Mechanisms developed will include (not an exhaustive list):
	  • Real-time actions/decisions in response to physical changes to operation (e.g., changes to pressures)
	  • Alarm management
	  • Market information provision
	  • Notification of gas flows
	  • Gas flow management
	  • Supply and demand forecasting
	  • Capability assessment and risk management
	  • Access to the hydrogen network and associated charges
	  • Gas trading
	  • Impact of methane network outages on hydrogen production
	• Review impact of options identified to existing methane operations and potential changes to existing operating strategies, guidelines, and risks

Emergency Management / Security of Supply: Work with NESO to develop a whole system Network Emergency Management process which incorporates a 100% hydrogen network to aid in security of supply	• Assess whether new or amended operational security standards and/or emergency and incident management processes are required • Work with the Office of Resilience and Emergency Management to build in 100% hydrogen network to whole system emergency management procedures
Legal and contractual implementation: Develop a suite of options which could enable the legal and contractual implementation of the physical and commercial mechanisms identified for the	• Legally and contractually assessed options for the implementation for physical and commercial mechanisms by economic and legal consultants

operation of the 100% hydrogen network	
Framework development: Support DESNZ by providing technical and commercial market framework expertise. Working along-side the industry to implement hydrogen market frameworks	• Developed hydrogen commercial market framework through working alongside the industry (as either support or lead) and utilising the technical expertise gained from our role in implementation and continued development of the methane market frameworks (Uniform Network Code (UNC) and associated frameworks)
System and Facilities: Develop scope and provide costs estimates for options required to deliver the physical infrastructure and IT systems to deliver the Project Union throughout its expansion phases	• Assessment of options and the potential and relative benefits of physically operating separate system for a single Gas Control Room (hydrogen and methane) vs. multiple separate control rooms, support facilities and associated infrastructure. How this may change over the phases of Project Union • Assessment of options for delivery of the IT system infrastructure required to deliver the hydrogen system operator activities and opportunities for new ways of working (e.g., automation, simulation integration)

Key Deliverables
The key deliverable of this piece of work is to scope out the system operation mechanisms required to physically and commercially operate a hydrogen backbone in its initial stages and throughout its expansion, informing the change required to be delivered before the first molecule of hydrogen is transported. This will include: • Operating procedures covering all elements of system operation for an early-stage hydrogen network including Network Emergency Management Processes • Indicative scope and costings for development of IT systems • An overarching pathway plan exploring the additional steps a hydrogen system operator will need to take as Project Union expands

Table 26 - System Operations Key Outcomes, Success Criteria and Deliverables

Network Modelling

The Network Modelling work package will build upon work delivered as part of pre-FEED, Network Modelling first pass repurposing backbone, to include transient analysis of entry and exit capability refinements. The further refinement of the Network Modelling Assessment aims to demonstrate the potential to repurpose elements of the existing methane NTS for up to 100% hydrogen while understanding the impact and intervention required for methane NTS. The work package will support the progression of asset interventions and / or investments required for methane NTS security of supply obligations (while also considering commercial options) and the optimising of new build options to ensure the most cost-effective option. Whist working on PU: Essential Enabling Activities for all sections, this work package will be critical to progress FEED.

Outcome	Success criteria
Specific assumptions for modelling activity to be actioned / progressed (volume and energy by network zone)	• Assumptions document produced and tested
Refined list of assets to be used in the modelling whether reused, refurbed, or new including all flow characteristics and parameters	• Specific assets listed, confirmed by Asset, that can be assumed for repurposing
Defined assessment of asset and network flow characteristics boundaries (pressure, velocity, quality)	• Linked to asset assumptions, network modelling inputs/parameters defined
Updated list of assets to be used in the modelling whether reused, refurbished or new including all flow characteristics and parameters	• Updated parameters for existing assets, following further Asset / Integrity review of pre-feed proposals
Further Network modelling assessment of new build options	• Full modelling assessment of specific new build options alongside repurposing
Assessment and input to a go/no go date for hydrogen asset transfer based on modelled outcome	• Collated modelling results and risks in agreed format
Further assessment of risk (operational, constraint etc.) on the methane network from repurposing infrastructure	• Full assessment of existing network using existing parameters (constraint modelling, Annual Network Capability Assessment Report (ANCAR) etc.), documented constraints and risks under agreed scenarios
Flow assurance – build and validate our own network model in modelling software	• Supporting the engineering design of the network

Key Deliverables
• Network Modelling Assessment of new build and repurposing options • Examination of risk mitigation measures i.e. contracts, new infrastructure

Table 27 - Network Modelling Key Outcomes, Success Criteria and Deliverables

Construction

The Construction work package will estimate the construction implications of the overall sections of Project Union, developing a plan, risk assessment and cost estimations. This work package will provide specialist support to the Technical Delivery work package throughout the FEED phase to ensure successful preparation for transition to subsequent phases such as pre-construction.

Outcome	Success criteria
Estimation, planning and risk assessment- Refine estimates for all sections for funding submissions, develop more detailed end to end programme including delivery. Expanding on the risk registers with more information. Provide engineering expertise to inform FEED activities and delivery.	• Robust development and delivery cost estimates for all sections, to enable appropriate budgeting. • Delivery programme with the appropriate details that include FEED information with constructability sequencing, interdependencies, constraints and milestones • Risk and opportunities register with mitigation plans and quantifications to establish contingency values and business risks.

Key Deliverables
• Cost Estimation • Develop an end-to-end Construction Programme • Risk and opportunities register, including mitigation plans

Table 28 - Construction Key Outcomes, Success Criteria and Deliverables

Engineering Policy

The Engineering Policy work package will develop hydrogen specific technical standards to ensure the safe design, construction, commissioning, operation, and maintenance of the hydrogen backbone to be delivered by Project Union.

The ongoing pre-FEED work in the Engineering Policy work package is currently defining the following areas which are integral to the development of Engineering Policy Technical Standards:

I. Governance structure and framework for the delivery of hydrogen specific standards
II. Prioritised plan for delivery of technical standards development to meet the planned delivery of hydrogen
III. A review of external industry standards and research to harmonise our approach with industry and ensure efficiency in engineering policy development

During FEED, this work package will use the information from the pre-FEED to begin delivery of Engineering Policy to the developed plan by implementing the recommended governance structure and framework defined and setting technical experts to bring together industry / internal knowledge and research to develop hydrogen specific technical standards.

Outcome	Success criteria
Implementation and management of the recommended engineering policy framework (identified in Pre-FEED) that will be suitable for natural gas, 100% hydrogen and a blend.	• The framework will enable structured development of hydrogen specific standards alongside the existing development of natural gas standards • The recommended framework from the pre-FEED stage will be written into National Gas Transmission Policy
Implementation and management of the recommended engineering policy	• The established governance arrangements will enable structured development of hydrogen specific

governance arrangements (identified in Pre-FEED) for safety and technical approval.	standards alongside the existing development of natural gas standards, by enabling both safety and technical approval by the business • The recommended governance arrangements identified in the pre-FEED stage will be written into National Gas Transmission Policy
Begin to deliver the prioritised list of policy documents as per the prioritised plan developed within the Pe-FEED project phase. Continue to review the priority of the development of policy documents to align with the development of Project Union and to satisfy future phases of Project Union build. Where in-house expertise related to specific area of knowledge is not readily available, external expertise will be used for the development of policy documents to the prioritised plan.	• Policy documents will be delivered as per the prioritised plan that has been developed as part of the Pre-FEED phase • Continuous management and development of the plan to align to the development of Project Union • Engagement with ongoing internal and industry research projects to: (i) ensure that the ongoing research provides answers to gaps in technical understanding, through active participation in the research and influencing the research programmes (ii) ensure there is engagement of skilled engineers in ongoing research to develop knowledge base for delivery of engineering policy documents • Using existing industry research and knowledge, look to take advantage of this by purchasing this knowledge and learn from existing hydrogen operations.
Adoption of existing hydrogen policies as recommended by the Project Union Pre-FEED. Continuing review of existing hydrogen specific policies as they are developed.	• Development of adoption statements for existing external hydrogen specific policies for the adoption and use within Project Union as per recommendations from the Project Union Pre-FEED work

SME support with engineering and technical expertise on repurposing of existing assets and design of new assets, technical scoping, quality assurance, quality control and integrity related activities. This will ensure development of an optimised technical transition into subsequent phases.	• Repurposing and design activities supported through:
	  • Timely response to technical queries received
	  • Development of project scoping
	  • Quality Control and Assurance related activities
	• Integrity related activities

Key Deliverables
• Initial Engineering Policy Framework • Initial Engineering Policy Governance arrangements • Delivery of hydrogen specific engineering policies to the plan developed to support the delivery of the Project Union programme

Table 29 - Engineering Policy Key Outcomes, Success Criteria and Deliverables

Data

The Data work package will refine critical data specification for a future hydrogen network. Data gathering, collation and analysis for decided feeders. Implementation of a unique data storage for Project Union data. Data governance implementation for "must have" data including assignment of ownership and stewardship of the data collated. Continuous assessment of information requirements; linear and non-linear. Data enrichment via desktop exercises or physical data collection. Costing and plan for further data collection and potential engineering requirements. Capturing any additional data requirements (e.g., geospatial to support route mapping). The data collected will be used to feed critical outputs and deliver critical output/data to other workstreams.

Outcome	Success criteria
Asset differentiation and capture (hydrogen to methane)	• Data Specification updated for existing (to be repurposed) and new assets. Specification shared to relevant workstreams for data capture and use • Automated capture and storage of asset data (Project Union EMAT and ILI runs)
Data provision to different workstream and enrichment	• Data gap analysis completed based on data specification. Priorities plan and methodology created and in delivery. Feasibility datasets available for advanced modelling and options analysis Note: availability aligned to route phasing
Management of GIS data	• Integration of Project Union GIS data into systems to be visualised within online Web Application

Key Deliverables
• Metadata of all digitised data • Digitised primary data documentation

Table 30 - Data Key Outcomes, Success Criteria and Deliverables

Asset Strategy

The Asset Strategy department in National Gas looks after the Asset Management Strategy, Asset Management Planning and Asset Modelling functions of the Methane NTS. Given the interaction of repurposing current assets to hydrogen, the development of Project Union into FEED will require two main themes of work from the Asset Strategy department: (i) adapting the existing methane Asset Management Plans (AMPs) around Project Union specific requirements and (ii) developing overarching Hydrogen Asset Management capability.

Outcome	Success criteria
Reprioritising and moving existing methane investments for the methane NTS / AMP to adapt around Project	• Measurement of risk before and after transition • Candidate investment identification • Re-phasing of Asset Management Plan annually

Union individual phase route options to better facilitate Project Union (i.e., bringing forward above ground installation (AGI) surveys or In-line Inspections). Assess where additional cost or ultimately repeated surveys purely required for Project Union are needed, ensuring costs incurred are captured by Project Union funding and not the methane regulatory funding. This will also include optimising when is best to make these investments to provide the most efficient delivery of work across methane and hydrogen investments.	
Identifying new investment required to the retained methane network to minimise the impact due to Project Union repurposing or interactions with existing methane NTS asset. This may include additional investment to ensure valves or other assets critical to allowing Project Union outages are created and enacted ahead of their need.	• Measurement of risk before and after transition • Candidate investment identification • Re-phasing of Asset Management Plan annually
Identify where delivery outages and constraints might disrupt the deliverability of both Project Union and Methane network plans.	• Identification of planning clashes and ability to adjust both Methane plan delivery and hydrogen plan if required
Ongoing Hydrogen Asset Management approach, strategies for newly converted or newly installed hydrogen asset base. Including development of Hydrogen Network Asset Risk Metrics (NARMs) methodology for the retention, maintenance, and longevity of the Project Union assets.	• Establishment of a new hydrogen asset base asset strategy
Determining business priorities and value measures to facilitate the interactions and competing priorities of a hydrogen conversion network and exiting Methane networks. New investment CBAs etc.	• Asset Management Strategy activities embedded into company culture

Updating company policy objectives to reflect Asset management objective, CBAs etc.)	

Key Deliverables
• Reprioritised methane AMP to consider the use of hydrogen • Identified risk to retained methane network and assessment of new investment needed to secure reliability in methane network • Constrains and mitigations identified for dual hydrogen and methane system • New hydrogen asset strategy

Table 31 - Asset Strategy Key Outcomes, Success Criteria and Deliverables

People

The People work package is a new work package for this Re-opener, delivering a view of what workforce will be needed for the next phase of Project Union. By understanding what skills are required for delivering and operating a hydrogen transmission system this work package will identify the gaps that exist today and establish an approach to bridge these gaps so that the right people are in place at the right time.

Key Outcomes	Success criteria
Understand the workforce and skills required to deliver and operate a 100% hydrogen transmission network, identifying gaps in the market and how to bridge them	• Gap analysis conducted, identifying existing and potential gaps in skills required in a hydrogen market • An initial view of how the workforce may transition from methane to hydrogen • Proposed high level timeline of when workforce changes might be required over the subsequent phases of Project Union • Support work packages by informing potential new role requirements for subsequent phases

Key Deliverables
• Gap analysis of today's workforce against what is required to deliver a hydrogen transmission network

Table 32 - People Key Outcomes, Success Criteria and Deliverables

8.2.3 Linking scope of works to evidence needs

The top-down calibration of this phase scope is driven by the identification of evidence gaps that the 24-month programme will be aiming to address. We have mapped our programme of work to the strategic objectives set out by DESNZ to demonstrate how this work will inform policy and provide evidence to help shape priorities for Transport and Storage (T&S). We identified eight evidence points which fall into our broader three strategic objectives: promote net zero, whole energy system contribution, and market growth and economic benefits. [redacted]

[redacted]

The alignment of activities and outcomes to evidence points has been assessed at the lowest possible level in the design of this phase of scoping and costing. This provides a variety of different levels of detail. For instance, Table 33 below shows the contribution of individual work packages to the evidence groups and broader strategic objectives.

Work Package	Promote Net Zero	Whole Energy System Contribution	Market Growth & Economic Benefits	Total weight by work package
PU: East Coast				
Technical Delivery				
Lands and Consents				
Community Engagement				
Contract Management				
Market Needs Analysis				
Environmental Engineering				
Operations				
PU: Essential Enabling Activities				
Programme Management				
Implementation Strategy				
Technical Development				
Hydrogen Policy				
Supply Chain				
System operations				
Network Modelling				
Construction				
Engineering policy				
Data				
Asset strategy				
People				
% Weighting				

Table 33 - Evidence Gap Weighting by Work Package

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 34.

Price Base	2021/22	2022/23	2023/24	2024/25	2025/26	Total
[redacted]						
2018/19	[redacted]					81.829

Table 34 - Proposed Project Cost - Costs are shown inclusive of inflation adjustment and added contingency

Table 35 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)			**81.829**

Table 35 - Steps from nominal cost to total proposed costs including contingency

[redacted]

[redacted]

9.1.1 Cost plan build

Our approach to project cost development was a complex and detailed exercise, as characterised in *Figure* 22 below. However, the overarching aim was to ensure full integration of scope build, evidence need mapping, activity costings, and transparency of assumptions throughout. [redacted]

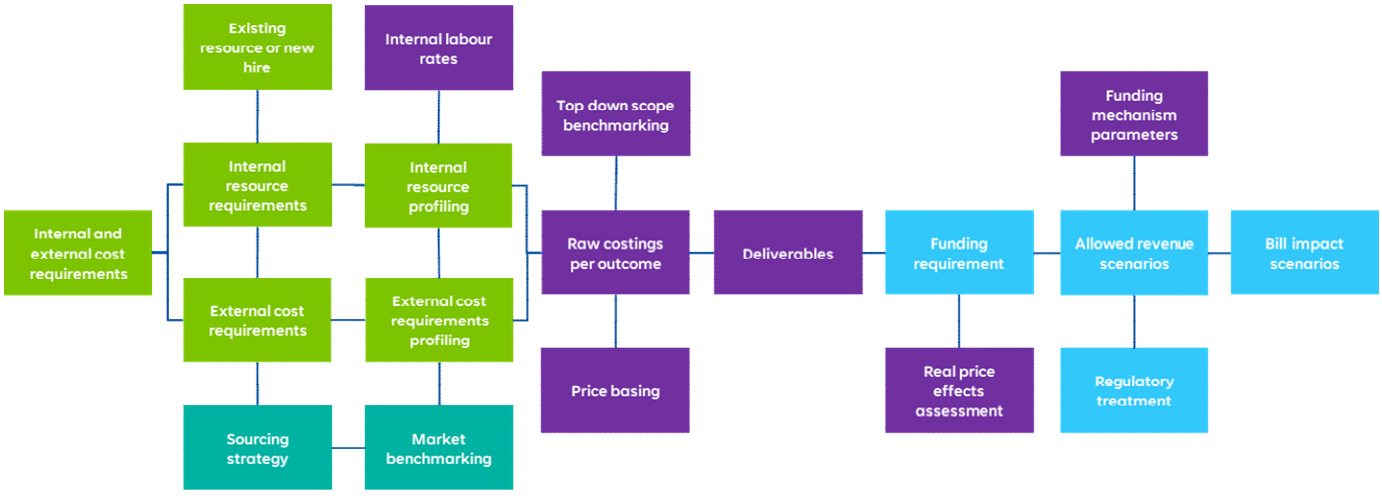


Figure *22* - Approach to Project Cost Development

Total costs for this submission carry a [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. [redacted]

9.1.1.1 East Coast 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 East Coast 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 East Coast 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 Project Union: East Coast, 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: East Coast.

Technical FEED:
An Engineering Consultancy will provide rigour and technical expertise for the development of the conceptual design of PU: East Coast 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 not identified a need for compression when considering flows on a 'static' basis i.e., steady state flow conditions. 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. In order 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.

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 East Coast region.

Once contracts are awarded for PU: East Coast 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: East Coast 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).

9.1.1.2 PU: Essential Enabling Activities cost composition and justification for funding

Work package	Internal	External	Total
Programme Management		[redacted]	

This work package will continue to operate as a central hub to drive project delivery and accountability for driving adherence to programme, outcomes, and cost.

Additional resources have been included in the Core Programme Management team to recognise the increase in workload supporting the whole programme. We have also included costs for supporting resources to provide: (i) assurance for the project and provide consolidated reporting and financial management, (ii) regulatory ownership for the Re-opener closure report which was a key deliverable requested by Ofgem as part of the last consultation and (iii) recruitment support activities within this work package. Please note we have not included any costs for workspace which was disallowed in the previous Re-opener.

Work package	Internal	External	Total
Implementation Strategy		[redacted]	

Funding for the Implementation Strategy work package is required to maintain momentum and progress the next phase of work for Project Union. This work package supports the broader programme by providing a definitive strategy for design and delivery, working with work packages across the programme as well as the wider business to align all technical, non-technical and wider requirements for successful delivery of Project Union at the right time to meet customer needs.

This work package requires a breadth of experience, namely across hydrogen market development, stakeholder management, programme delivery and business case development. The work package will drive coordination and alignment across all programme work packages to ensure the needs case for each section across Project Union as well as Project Union as a whole is relevant and considerate of new evidence established through later phases of the programme.

A critical role of this work package is to develop an updated view of the phasing strategy based on new information and evidence provided through the next phase of work as well as market advancements and policy decisions. The work package is responsible for aligning across NGT, from blending to system readiness, and work with industry, regulators and government to understand the policy change and decisions, hydrogen readiness and the role it will play in a whole energy system.

Our work with [redacted] for Feasibility phase of Project Union has provided an initial view of the phasing strategy, and social-economic benefits of delivering our proposed transmission infrastructure. Our intention is to continue to partner with an economic consultant through the delivery of next phase so that future funding request are supported with updated independent assessment and to develop the ongoing benefits of delivering Project Union. External cost estimates are based on recent costs to deliver the Phasing Strategy and Economic Assessment.

Work package	Internal	External	Total
Technical Development		[redacted]	

In order to ensure a robust proposal from technical and consenting perspectives it is necessary to continue to build on and develop the work undertaken during the Feasibility phase. This will include managing any necessary inspections and tests to confirm the technical suitability of pipelines for repurposing, in parallel with the continued assessment of routing options to ensure a robust foundation for any future consenting processes. As customer requirements also continue to evolve and projects move closer to construction, it is also critical to maintain a close technical dialogue to ensure that customer and network designs are aligned.

Repurposing existing pipelines for hydrogen use offers significant benefits. Initial assessment during the Feasibility phase has determined that, based on existing asset data, there are no fundamental reasons why the pipelines selected may not be repurposed. Further work is required to continue to build the evidence base supporting this decision. Inline inspections of shortlisted pipelines, using innovative new technology, will need to be undertaken to gather additional data on current pipeline condition. This may need to be supplemented by invasive tests to gather material samples at specific locations.

The Feasibility stage work has concluded that a fully repurposed network is not technically possible bringing a requirement for targeted new build sections of pipeline. These new build pipelines will need to follow the appropriate consenting regime. The foundation for any consenting process is a rigorous, comprehensive and transparent assessment of all route options to develop a fully evidenced preferred option. A core concept of the route assessment is continual backchecking and validation of options to ensure that preferred options continue to be justified. This is particularly critical in the early stages of project development where there is greater uncertainty and potential change in project requirements.

One of the key factors that will continue to evolve during the next stage of project development is customer requirements. Whilst customer engagement will continue as a BAU process, there is a need for specialist technical engagement and support for customers to ensure that the interaction between customer project design and network design is fully understood. This is particularly important in the early days of developing a network where individual projects have the potential to have a disproportionate impact on the network as a whole.

The cost of this work package has increased due to the increased duration of the FEED phase of work vs pre-FEED and the change in the scope of works delivered.

External services in this work package include engineering Consultancy support to review existing National Gas GS(M)R Safety Case and assessment of requirements to enable hydrogen transition on NGT documents.

Work package	Internal	External	Total
Hydrogen Policy		[redacted]	

There are a number of European countries, and the EU overall, who are looking to develop a hydrogen market. There are a large number of country specific and also EU wide policies that are currently being developed and implemented. An assessment of these policies, and their expected impact on the development of local and regional hydrogen markets would potential help guide the development of hydrogen policy in the UK. In addition, we believe that there will be the potential for the import and export of hydrogen to Europe. Therefore, the interaction of hydrogen markets and the policy drivers will be critical to our ability to import and export hydrogen.

External consultant research and analysis on international energy policy on hydrogen developments and their impact on the ongoing development of Project Union to allow for strategic objectives such as hydrogen trade. These costs are estimated based on previous costs from innovation projects, with similar timescales for completion and expected consultant involvement. The estimation considers projected time for consultant support.

Work package	Internal	External	Total
Supply Chain		[redacted]	

Without strong concentration on supply chain the additional risks of cost overrun, programme delay due to resource constraints and poor supply chain partners are increasingly more likely. The Supply Chain workstream will enable NGT to drive cost and quality through strategic procurement processes to select the best available supply chain partners.

Funding includes one existing category manager and hiring additional category managers to be responsible for researching, understanding, and analysing each component category of Project Union, new pipelines, repurposed pipelines, products, systems and construction services. These categories will be lifted up into the overarching strategy. This allows the overarching model to understand the risks, interdependencies, interfaces, innovations and best practises per category rather than it being considered only at a top level. The knowledge of the category managers is pivotal in driving best value under any contracting model selected.

Each category manager will have supporting resource which will look at drafting of procurement documents, market engagement and Supplier Relationship Management (SRM) processes, analysing data, and running procurement processes. The complexity of these operations is high due to the expected expenditure level and scope of the project. Additionally, a pool of junior resources has been included to support across all category areas, given the high value and expected volume of call-offs and procurement activity required. This structure will be more cost effective than having permanent resource tagged to each category area. Due to the wider market boom in construction pre-contract resources are at a premium. Where possible we will use flexible resource to augment to ensure we can get full utilisation of resources.

The resources considered in this submission don't include focused material expeditors to ensure high volume with long lead time items for the construction phase of the project arrive on time, to quality and do not cause any delay that could negatively impact the overarching project. This cost for long lead items and resource associated will be included in subsequent funding applications.

External services in this work package include:

Legal support required to develop resilient contract frameworks for the project. This includes draft the framework agreements, call-off mechanisms and assurance of all procurement related documents created by NGT. We have therefore assumed a large complex procurement model that allows holistic contracting for FEED and smaller ad hoc frameworks/contracts to be put in place to support Project Union. Cost estimates are based on previous costs of contracts that have been extrapolated for Project Union, which will likely to have a larger and complex contracting strategy and will require a more detailed assessment.

Consultancy support for the development of the contracting procurement strategy to deliver value for money to Project Union. Typically, we organise sprints via a consultancy to fact check and re-validate internal thinking to keep costs to a minimum. Cost estimates are based on previous consultancy cost for major projects that have been extrapolated for Project Union as there is broader core competencies for a project of this scope compared to the benchmark analysed projects.

Systems costs include subscriptions to tendering platforms, Achiles, subscription for data and other systems for [redacted] new hires across the supply chain and contract management work packages.

Work package	Internal	External	Total
System Operations	[redacted]		

Project Union cannot operate without a System Operator. It is likely that the most efficient and effective way of operating an emerging hydrogen "network", initially as a singular pipeline, underpinned by as a nascent, emerging market, will be very different to the operation of the natural gas network, which is an integrated, multi-asset network underpinned by an established, fully functioning, liquid market. By the time we pack the first molecule of hydrogen into the pipeline connecting the first two industrial clusters on the East Coast, which we expect to be in use by 2028, the mechanisms to enable the operation of this initial stage of the hydrogen "network" needs to be in place.

This piece of work will define operating procedures, physical and commercial mechanisms, emergency arrangements as well as IT systems and facilities required to operate the initial stage of Project Union, and subsequent phases. It will not be delivering any required changes (funding would be requested through an appropriate funding mechanism once the scale of changes is known). Consequential delivery of changes may require amendments to, or development of new operational processes, IT systems, frameworks, physical infrastructure. Delivery of those changes, with appropriate stakeholder engagement, could take a minimum of six months but could take years. Using IT system development as an example, a light touch update to the Gemini system involving change to microservices with minor third-party impacts requiring testing would take

between 6-12 months to implement. Alternatively, a significant change with multiple new microservices with a significant impact on all aspects of the system and third-party systems would take over two years. Therefore, to enable the delivery phase to be completed in 2028, work needs to start now on defining the system operation mechanisms needed for the first phase of Project Union giving sufficient time for delivery and implementation of change before the first molecule(s) of hydrogen enter the pipeline.

The work we have outlined above is vital for the success of Project Union, it will set us on a pathway requiring significant industry engagement and must be delivered at pace, starting now, to ensure that the System Operator has the tools needed to manage Project Union by the time it is operational.

The system operation work package is requesting funding for external consultancy to help deliver two outputs. Early in the funding period, a set of hydrogen supply and demand scenarios for each phase of Project Union are to be produced. These will be based on a range of potential regulatory decisions and subsequent network end-states; they will provide a basis for further development of the system operator processes and requirements. Working from this basis minimises the risk of proposed solutions being incompatible with operation of a future hydrogen network. The second output is a full legal and economic analysis of proposed solutions to ensure they would be compatible. In addition, regular inputs will be sought, from external consultancy as well as industry, throughout the development process to assist in keeping development in line with regulatory, commercial, and legal expectations. The aggregated cost estimates submitted are based on quotes provided, for works of a similar nature and scope, by consultants in each area: economic, technical, and legal.

Work package	Internal	External	Total
Network Modelling		[redacted]	

Further resilience analysis needs to be assessed within the FEED study associated with the capability, operational and resilience risks raised in pre-FEED. Additional work is required to fully understand the impact on the operability of compressor sites [redacted] and be aligned to the current Resilience standard that is being developed within NGT. Network Modelling continues to show a strong link between high demand conditions and the behaviour of key local supply points in ensuring 1 in 20 compliance. Further work needs to be completed to understand the scale of mitigation measures and how these interactions are likely to develop across the transition period. i.e., between repurposing of the pipelines to hydrogen and the transfer of sufficient demand from the methane network to hydrogen.

Work package	Internal	External	Total
Construction		[redacted]	

The construction work package activities and associated cost are related to the planning, estimation and risk resources required. The FEED phase involves many activities with interdependencies and constraints that will require effective management through planning, utilising the appropriate tools (e.g., Primavera P6) operated by experienced planners. Efficient planning ensures minimising waste and cost by avoiding duplication, unproductive time and tracking progress to meet milestones.

Robust estimation is essential during FEED to ensure appropriate budgeting for all the activities and cost efficiency through effective interrogation of tender prices and positive negotiations. In addition, the estimators will ensure that the project delivery cost estimation is robust, market value, includes the information resulting from the FEED phase and reflects the programme, project complexities and engineering difficulties.

It is paramount to control the risks during the lifecycle of any project, particularly a complex, multidisciplinary and high-profile project such as Project Union. The risk engineers will ensure capturing all the risks and opportunities related to the activities involved in the various stages of the project development and delivery, by holding risk workshops and producing risk registers. Risks will be assessed with regards to probability of occurrence, cost impact and mitigations needed to either eliminate the risk or minimise the impact. The mitigation plans will be allocated owners and completion dates which will be included in the detailed delivery plan.

Work package	Internal	External	Total
Engineering Policy		[redacted]	

NGT currently has over 550 documents at policy trough to work procedure level. To begin to delivery of hydrogen engineering policy, it is anticipated that a central policy team is required to manage the governance structure and delivery framework and a team of technical experts is needed for developing these hydrogen specific documents. Each document that is produced will be required to go through a governance process that ensures all impacts & mitigations have been put in place through engagement with key stakeholders within the business and implementation methods for their future use are well documented. This will require significant engagement with the wider business and is key for the development of a well thought through standard. Internal costs also include the development of policy documents from the prioritised plan as well as external hydrogen specific policies that will require partial time from existing resources to be dedicated to Project Union. The engineering policy team includes policy engineers for Materials, Pipelines, Corrosion, Welding, AGIs, Rotating Machinery, C&I, Electrical, Safety, Gas Quality, Metering, Telemetry and Electrical Integrity, supported by partial time of the Engineering Managers of these specialisations. Additionally, this work package will support technical queries, scoping and quality control assurance for the safe design, construction, commissioning, operation, and maintenance of the hydrogen backbone to be delivered by Project Union. It is essential that this work is delivered alongside the FEED to ensure timely delivery of Project Union which support customers and their timelines to decarbonise.

It is anticipated that there will be instances where the expertise for development of policy and procedure will not be available within house and there may be requirements to appoint consultants with specific areas for technical expertise. Cost estimates have been based on previous experience given the number of document reviews to conduct and the typical number of document reviews that would require external consultant support for development.

As part of the Feasibility phase, several areas of hydrogen development within the wider industry have been identified. Having access to the correct forums and purchasing the correct external hydrogen related research will contribute to streamlining the development of technical standards by accessing existing knowledge through literature and ongoing forums. Fees and charges to obtain

access to external literature and join relevant hydrogen focused forums to enrich our approach within industry to develop policy documents have been included. Cost estimates are based on previous experience considering the cost of access to external literature and research and participation in external hydrogen focused forums.

Work package	Internal	External	Total
Data		[redacted]	

Digitising archived data is essential for repurposing our pipelines for Hydrogen. Given the unique properties of Hydrogen gas, accurate and reliable data is crucial. We have identified key data requirements for Hydrogen and are now digitising archived data to ensure easy access and usability, ultimately aiding decision-making for Hydrogen asset repurposing.

The data collection team comprises a range of expertise, including a data program manager, Head of Assets, GIS specialist, and several data analysts, all crucial for the data collection and documentation efforts. New hires of additional analyst have been considered due to current analysts' capacity being oversubscribed (unable to dedicate time to Project Union) and the need for specific expertise on document storage and analysis required. The Head of Assets will allocate partial time to ensure access to NG document management systems and provides training to the data analysts.

Given the large volume of data being gathered and the digitisation of over 80,000 boxes of archive data to create primary documentation for the safe repurposing of hydrogen, a third party has been contracted to digitise the documents in batches.

The expertise of the data analysts is essential for effectively analysing and documenting metadata for each scanned asset. Additionally, we are in the process of constructing a document storage site specifically for the project. The data collection team is responsible for facilitating data collection, storage, and access, particularly for hydrogen repurposing.

External services consist of digitised archive data required for the safe repurposing of pipelines to transport hydrogen. These documents include pipeline construction original certifications, over A0 sized wielding bar charts. Given the large volume of data being gathered and the digitisation of over 80,000 boxes of microfiche files, a third party will be contracted to digitise the documents in batches. We currently do not have the facilities to scan these files and it will be more costly both in time and money to employ people to complete the scans. The cost estimates were benchmarked from previous scans executed during the Feasibility phase of Project Union.

Digitising data assets is a manual process and is very resource and time intensive. The alpha phase of the HyNTS project digitalised Feeder 6 data as a proof of concept, however, it was recognised that this process could be made more efficient with automation. The requested Azure resources would enable automation to support manual efforts and therefore reduce amount of manual entry required, this will reduce the overall project costs for digitalisation. These costs also would enable the setup of a geodatabase which is an essential component of the project deliverables.

Work package	Internal	External	Total
Asset Strategy		[redacted]	

Funding for the Asset Strategy work package is limited to people resourcing only. The Copperleaf Asset Investment Planning tool which is already being used will be capable of adaption via additional employee resource design and amendment to accommodate hydrogen assets and investments. Therefore, at this time we have not identified the need for any external procurement of additional systems or services to support Project Union FEED.

The Asset Strategy department is split into three core teams: Asset Management Planning (AMP), Asset Modelling and Asset Management Strategy. All areas of the team will need to facilitate the delivery of outcomes described above.

The AMP team will require partial time from existing members of the team to account for the interaction across the whole methane investment plan. The AMP team has four distinct sub teams: Sites, Pipelines, Compressor and Security. Hydrogen and consequential methane investments will interact with all elements of the Asset Management Plan. The increased workload specifically to include hydrogen investments themselves, as well as identifying, assessing, developing, and creating responsive methane investments will require [redacted] Asset Managers. These Asset Managers will cover all asset investment across the four sub teams. These activities will sit above and beyond the existing methane asset management planning activities, and their careful and successful integration with the methane plan will be critical to maintaining a safe methane NTS and maintaining security of supply.

The Asset Modelling team own and facilitate the use of the Single Value Framework and processes. This allows the business to uniformly measure and calculate asset probability of failure, consequence and risk for business plans and regulatory reporting. The team will require a dedicated Lead Asset Modeller to facilitate the Copperleaf evolution to incorporate hydrogen investments, risk, benefit and development of the Single Value framework to accurately value and model competing methane and hydrogen investments.

The Asset Management Strategy team will require an Asset Management Strategy Lead to develop a new suite of strategies, desired states and valuing the long term asset management plans for the newly installed or newly repurposed hydrogen asset base. These new strategies need to be fully embedded within business Asset management capabilities.

Work package	Internal	External	Total
People		[redacted]	

This work package requires a dedicated lead to undertake a robust gap analysis and understand the workforce and market requirements to deliver a hydrogen transmission network for the next phase of Project Union as well as for the future operation of a hydrogen transmission network. Support from the Strategic Workforce Planning will also be required to understand the cross over and transition from methane skillsets.

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 11. Regulatory Treatment and Impact, we propose that any unspent allowances are returned to consumers in full.
- **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[37]. 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.

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

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

Project Union is multi-year programme that once complete will provide a hydrogen transmission network connecting industrial clusters and strategic storage sites across the UK and support government targets to achieving net zero.

Under the Green Book Supplementary Guidance for Optimism Bias[38] Project Union is characterised primarily as a 'non-standard civil engineering project' whilst also including properties of an 'equipment and development'. As such this guidance suggests, without mitigating factors, a range of 66% to 200% of project value as a suitable figure for risk.

Due to its scale and nature, Project Union has complex risks, and thorough programme planning, and delivery will mitigate against these risks using industry experience and Green Book Supplementary Guidance. There are three key types of risks impacting the programme, outlined in Table 37.

External Risk	Technology, Research & Innovation	Large Scale Construction
Risks associated with multiple stakeholders and customers, market and economic factors, regulatory policy, national environmental policy, and the reactions of the public to cost and environmental issues.	Risks associated with novel technology, research, innovation, the ability to re-use existing assets and develop new standards and supplier markets for hydrogen compatible equipment.	Risks associated with undertaking large-scale construction works, with significant potential land take, major local environmental impacts, constrained supplier markets and large-scale logistics.

Table 37 - Green Book Supplementary Guidance Key Risks

The risk associated to PU: East Coast 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.

Based on our assessment of risk, a total contingency for this submission of [redacted] at 2018/19 price which represents [redacted] of the total cost of the project. The Three-Point Estimate Technique

[38] Green Book supplementary guidance: optimism bias - GOV.UK (www.gov.uk)

has been used to calculate the contingency required. To develop the contingency value, each risk was assessed for probability of occurrence and the minimum, most likely and maximum risk impact cost value has been established. The mean cost impact value for each risk was calculated using the formulae: (Max + (ML x 4) + Min)/6 and the risk impact cost expected value was calculated by multiplying the mean cost value by the probability. At this stage this methodology is deemed sufficient, meanwhile, we are continuing to refine contingency value by using the Monte Carlo simulation to the risks included in the risk register using our risk management software 'Predict'".

[redacted]

Returning to the Supplementary Green Book Guidance for Optimism Bias, the Guidance identifies key areas where successful mitigation of risk can take place shown in Figure 23 below.

Green Book Guidance for Optimism Bias - Key Risk Mitigation Areas
Economic
Degree of Innovation
Late Contractor Involvement in Design
Adequacy of Business Case
Design Complexity
Technology
Complexity of Contract Structure
Potential Disputes and Claims

Figure 23 – Green Book Guidance Risk Mitigations

It is believed the risk value included in this submission provides the most effective way of reducing the total spend incurred by government or gas bill payers, given the size and scale of the programme. The failure to tackle these risks effectively in the proposed works could result in extra spend on Project Union in future years.

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)[39] 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 East coast 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 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 [redacted], 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

[39] 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/

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.

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 24. 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.

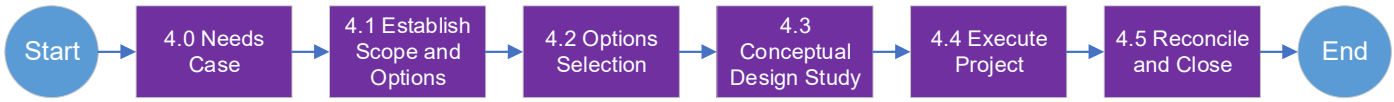


Figure 24 – ND500 Process

10.1 FEED Phase Project Governance

A governance structure to support the Project Union FEED Phase has been established in Figure 25.

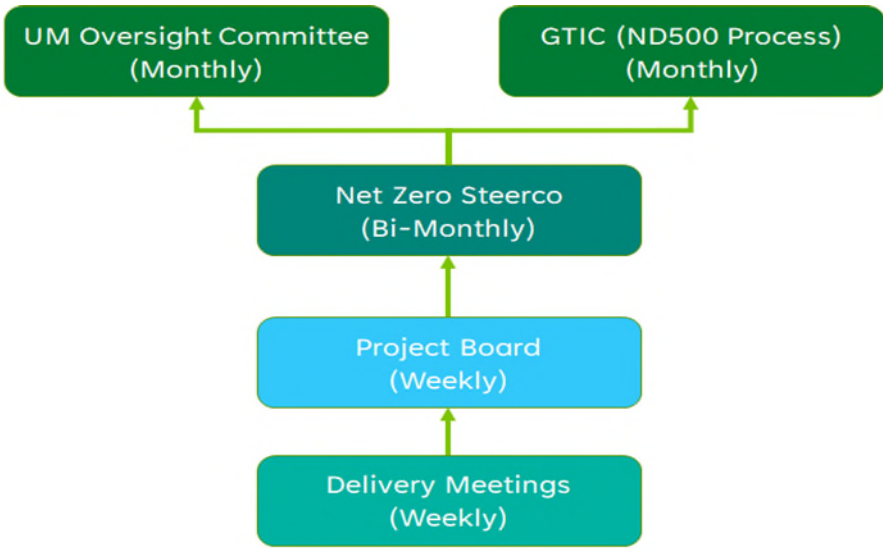


Figure 25 - Project Union Governance Structure

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. This will cover the overarching activities included in this reopener as well as the plan for the section specific FEED activity.

10.3.2 Deliverables

ND500 Deliverables

Table 38 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	June-July 2024	Date dependent on consultation response
4.3 Conceptual Design and Development (Pre-Construction)	• Conceptual Design • Scope Freeze	T4	Apr-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	May-2026	
		T5	June-2026	
4.5 Acceptance/Closure	• Post commissioning handover to GT • Operational acceptance • Project Closure	T6	Apr-2031	
		F5	July-2031	

Table 38 - 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 39 and Table 40 below. Note that project deliverable deadlines are subject to a funding decision and expected start date of May 2024.

PU: East Coast Deliverables

Reference	Work Package	Project Deliverable	Deadline	Evidence
PU:EC1	Technical Development	Finalised short list of preferred technical option(s) to take forward to Conceptual Design East Coast	Jan-25	Finalised short list of preferred technical option(s) to take forward to Conceptual Design East Coast
PU:EC2	Supply Chain	FEED Framework	Jan-25	FEED Framework in place
PU:EC3	Lands and Consents	Consultation Strategy	Apr-25	Consultation Strategy in place
PU:EC4	Lands and Consents	Route Corridor Study and Preliminary Route Report	Apr-25	Route Corridor Study and Preliminary Route Report
PU:EC5	Construction / Technical Delivery	Construction Programme for Next Phase of work	Jan-26	End to end Construction Programme for next phase of work

Table 39 - PU: East Coast Deliverables

PU: Essential Enabling Activities Deliverables

Reference	Work Package	Project Deliverable	Deadline	Evidence
O1	Programme Management	Detailed Delivery Plan for current phase and section	1. Jul-24 2. Sep-24 3. Dec-24 4. Mar-25	1. Confirmation that an Overarching Activity and East Coast Hydrogen Section current phase detailed delivery plan is in place. 2. Confirmation that sections 2-3 FEED have been incorporated into the delivery plan 3. Confirmation that next sections of FEED have been incorporated into the delivery plan 4. Confirmation that final sections of FEED have been incorporated into the delivery plan
O2	Implementation Strategy	Full Hydrogen Backbone Phasing Strategy	Oct-25	Revised Phasing Strategy incorporating knowledge and learning from FEED phase
O3	Data Collection	Data collection	1. Aug-24 2. Jan-26	1. Data Collected and available in system for East Coast Hydrogen 2. Data Collected and available for remaining sections
O4	Network Modelling	Network Modelling Assessment of new build and repurposing options	1. Jan-25 2. Oct-25	1. PU: East Coast 2. Remaining Sections
O5	Engineering Policy	Delivery of hydrogen specific engineering policies to the plan developed	Apr-26	Complete for all sections
O6	Programme Management	Re-opener Closure report	May-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 40 - PU: Essential Enabling Activities Deliverables

10.2.2 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.

10.2.3 Resource Management

Existing and new resources will be required to deliver PU: East Coast 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 and 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 Mechanisms Appraisal

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 multilateral sessions involving Ofgem, DESNZ, NGN and Cadent, in addition to bilateral sessions with Ofgem. Initial multilateral sessions commenced in January 2023 and our bilateral engagement meetings with Ofgem commenced in May 2023 and continued through to 2024. We have provided a summary playback of these discussions in Appendix B.

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 £81.829 million represent an increase of [redacted] on baseline Gas Transmission TOTEX funding for RIIO-2 which will have a minimal impact to bill payers based on our proposed regulatory treatment [see 11.3].
- **Policy alignment**: as demonstrated in 5. Needs Case, 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[40] published in August 2023. We have worked with Government and Ofgem to share learnings from our Feasibility phase work to provide substantial evidence in

[40] 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. The programme will also provide a key link to major regional projects to contribute to an overall national UK approach. Regional projects such as East Coast Hydrogen will utilise re-purposed or new build infrastructure developed through Project Union highlighting the crossover between the two projects and the role Project Union will play in regional net zero targets.

    - 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 application, 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 we should be protected for any overspend.

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-openers applications and the need to protect methane customers from bill spikes puts to test the durability of the "fast funded" approach.

(b) The inability of a fast funded approach to facilitate equitable and fair intergenerational cost allocation which TOTEX founding allows for, will reduce the short-term allocation of cost to methane users.

(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 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 and any cost of overspend is shared.

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[41].

- **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.

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

- **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.

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 the East Coast, ensures we can deliver a focused evaluation. Broad Project Union 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 Broad Project Union activities are completed in tandem, to an East Coast focused FEED, to ensure efficiencies across the programme.

5. European policy for hydrogen continues to evolve with targets of 20Mt 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, and Broad Project Union, 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 inside RIIO-2 years one to three 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 the submission have been discussed with Ofgem in a series of pre-/post-trigger multi-lateral, and bi-lateral, engagement meetings taking place between January 2023 until final submission in April 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
AMP	Asset Management Plan
ANCAR	Annual Network Capability Assessment Report - Reporting document in which National Gas calculate and demonstrate the physical capability of the NTS and how that capability compares to the needs of our customers now and into the future
ASTI Framework	Accelerated Strategic Transmission Investment Framework
BAU	Business as Usual
CAPEX	Capital Expenditure
CBA	Cost Benefit Analysis
CCC	Climate Change Committee
CCGT	Combined Cycle Gas Turbine
CCUS	Carbon Capture Utilisation and Storage
CPIH	Consumer Price Index (including owner occupiers' housing costs)
CPO	Compulsory Purchase Order
DAG	Data Assurance Governance
DCO	Development Consent Order
DESNZ	Department of Energy Security and Net Zero
DEVEX	Development Expenditure
DST	Decision Support Tool
ECH_2	East Coast Hydrogen - A collaborative project between National Gas, Cadent and Northern Gas Network
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
GIS	Geographic Information System - 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
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
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
I&C	Industrial and Commercial
ILI	In-Line Inspection - an internal inspection technique for our pipelines
LPA	Local Planning Authority
LTS	Local Transmission System - The pipeline system operating above seven bar that transports gas from national transmission system offtakes to distribution systems
MCA	Multi-criteria Analysis
MOP	Maximum Operating Pressure
MOU	Memorandum of Understanding
MPT	Multi-criteria Phasing Tool
MST	Minimum Spanning Tree
Mt	Million tonnes
MW	Megawatt
NARMs	Network Asset Risk Metrics
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
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

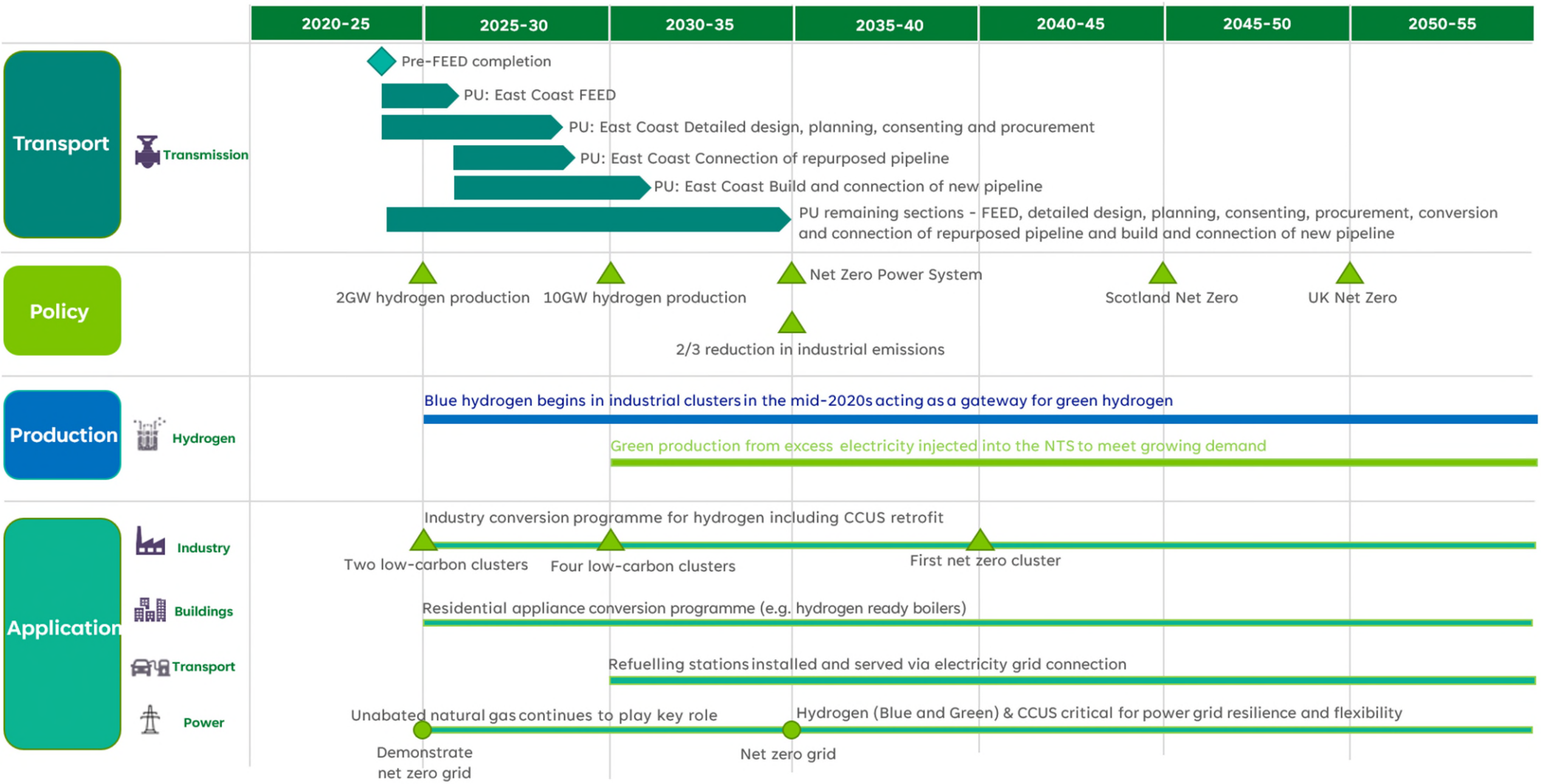
	capital projects that will enable the achievement of net zero carbon targets
NZHF	Net Zero Hydrogen Fund
OASTs	Options Appraisal Summary Tables
PCFM	Price Control Financial Model
PEIR	Preliminary Environmental Information Report
PINS	Planning Inspectorate
PU	Project Union
PU: East Coast	Project Union: East Coast
PU: Essential Enabling Activities	Project Union: Essential Enabling Activities
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
SIF	Strategic Innovation Fund
SME	Subject Matter Expert
SRM	Supplier Relationship Management
T&S	Transport and Storage
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
TPC	Transmission Planning Code
TWh	Terrawatt hours
UCR	Utility Contract Regulations
UM	Uncertainty Mechanism
UNC	Uniform Network Code

15. Figures, Tables and Supplementary Documents

[redacted]

16. Appendices

Appendix A – PU: East Coast alignment to wider strategic objectives



Appendix B - 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 January 2023.

Table 41 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 - ECH_2 Delivery Plan - 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 - Being a vital stakeholder, Ofgem representatives were invited to the ECH_2 Delivery Plan launch event hosted by NGT, NGN and Cadent in November 2023
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 41 - Pre-trigger engagement requirements

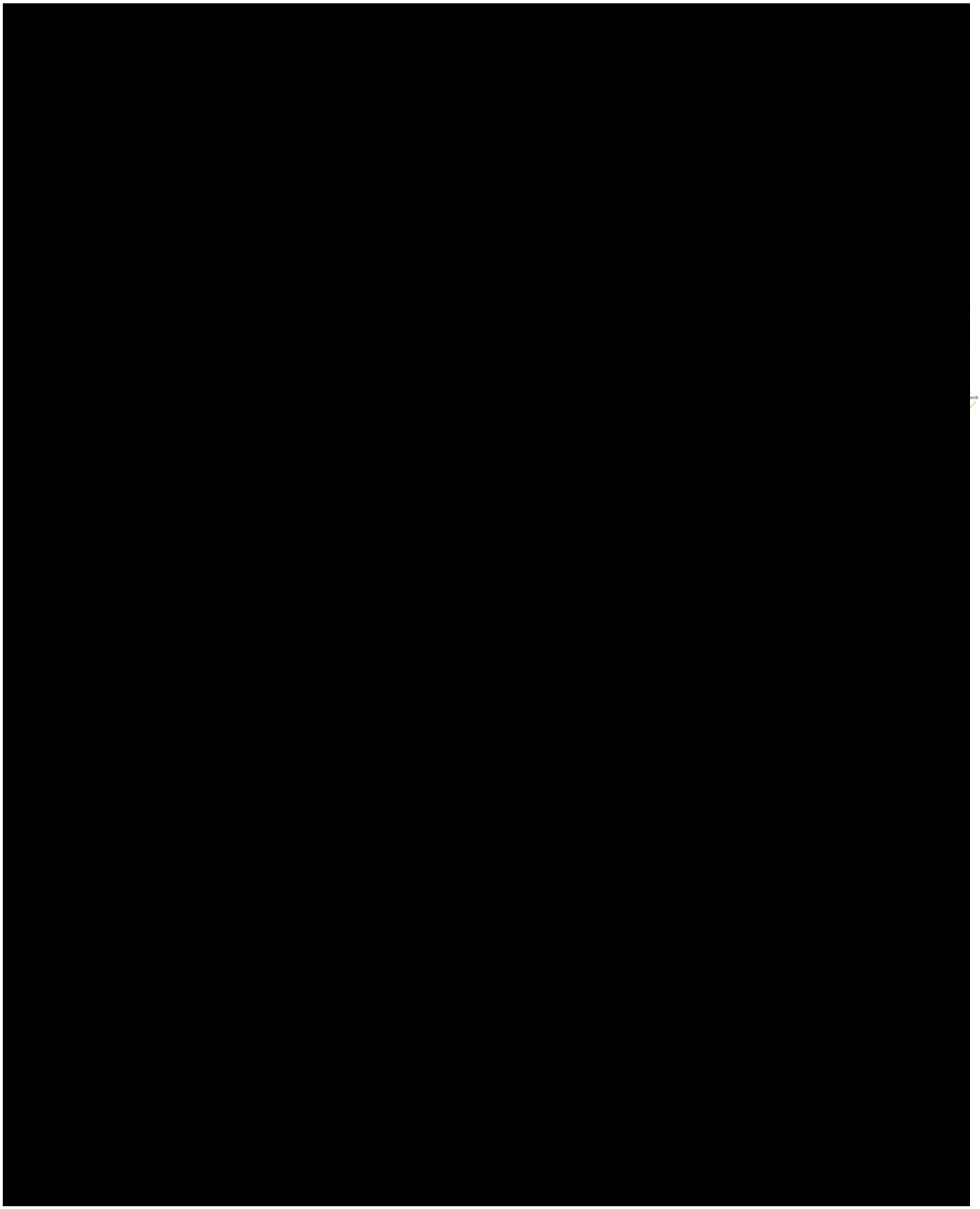
As part of our pre-trigger engagement with Ofgem we have held a series of meetings since 2023 to discuss the progress and strategic direction of PU: East Coast. These meetings have been informative in helping us to build out our re-opener scope and structure. A summary of the engagement held with Ofgem to date is included in Table 42 below.

Date	Topic	Attendees	Key Discussion Points
09/01/2023	ECH_2 Introduction	[redacted]	- Overview of the ECH_2 project and the specific objectives - Application approach across the three networks - Understanding Ofgem's pre-trigger engagement period requirements - Appropriate funding mechanism and contribution Alignment to Ofgem engagement activity: What is being proposed? and how the funding should be treated from a regulatory point of view.
19/05/2023	ECH_2 Re-opener approach	[redacted]	- Discussion surrounding the progress of pre-FEED across the networks - Engagement approach - Approach for re-opener development and submission - Delivery plan approach and interconnection between networks Alignment to Ofgem engagement activity: What is being proposed?
29/06/2023	ECH_2 Production needs case	[redacted]	- View of hydrogen production within the region - Continued progress update discussing approach for repurposed vs new build - Market based options - Ensuring costs are market competitive and justified - Incorporating EJP requirements into the re-opener - Re-opener submission timelines Alignment to Ofgem engagement activity: What is being proposed? And The timelines for the project including its anticipated length and the

		[redacted]	submission dates for the detailed assessment phase
26/07/2023	ECH_2 Demand and storage needs case	[redacted]	- ECH_2 needs case for hydrogen - How the networks built out the demand forecast - Alignment with key government targets Alignment to Ofgem engagement activity: What is being proposed? And The aim of the project and evidence that it fits into wider strategic goals
24/08/2023	ECH_2 Pre-FEED discussion	[redacted]	- Pre-FEED technical progress and design maturity - Taking optionality into FEED - Implications of emerging policy such as Hydrogen Transport and Storage (T&S) business models - Pre-trigger engagement health check Alignment to Ofgem engagement activity: What is being proposed?
12/10/2023	ECH_2 CBA and options assessment	[redacted]	- Overarching approach to CBA and individual networks CBA approach - Guidance for CBAs from Ofgem - Management of uncertainty Alignment to Ofgem engagement activity: What is being proposed? And The project cost

		[redacted]	
24/10/2023	ECH_2 Pre-trigger document structure and ECH2 benefits	[redacted]	- Re-opener trigger and submission document structure - ECH_2 benefits - ECH_2 delivery plan launch Alignment to Ofgem engagement activity: What is being proposed? The aim of the project and evidence that it fits into wider strategic goals and the timelines for the project
05/12/2023	NGT Net Zero	[redacted]	East Coast focused discussion: - FEED scope and associated costs - Working assumptions on suitability of NZASP regulatory funding - Customer bill implications of this funding approach Alignment to Ofgem engagement activity: The project cost, 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?
11/12/2023	ECH_2 Engagement	[redacted]	- Case for natural gas customers including why bill payers should pay and specific benefits for natural gas customers. - ECH_2 phasing strategy. - Hydrogen production vs demand over time - Networks approach to submission Alignment to Ofgem engagement activity: What is being proposed? Why is it appropriate for this to be funded by network consumers through this re-opener?

Table 42 - Summary of Ofgem pre-trigger engagement



Appendix DD - Redaction Explanatory Statement

The "Project Union: East Coast Net Zero Pre-construction Work and Small Net Zero Projects Re-opener" was submitted to Ofgem on 30th April 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

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