East Coast Hydrogen

Paper 3 - Engineering Justification Paper

Contents

1 Introduction

Northern Gas Networks (NGN) are the company responsible for distributing gas to homes and businesses across the North of England, an area covering West, East & North Yorkshire, the North-East and Northern Cumbria. NGN have commissioned a consultant, to carry out a Pre-FEED study for their Eastern region – "East Coast Hydrogen" to support the Net Zero and Small Projects (NZASP) Re-opener and subsequent project phases e.g., FEED study. East Coast Hydrogen (ECH_2) aims to connect the areas industrial clusters with other supply points, such as the East Midlands Hydrogen Innovation Zone and users in the region. The project needs an efficient way to enable hydrogen export across the North of England, bringing seamless conversion of businesses to 100% hydrogen (subject to government's decision) where it is best deployed.

This collaborative programme between Northern Gas Networks, Cadent Gas and National Gas (NG) represents an opportunity for the Government and the private sector to work together in delivering on the ambitious decarbonisation targets. ECH_2 has the potential to connect at least 5.6GW of hydrogen production by 2030, this alone would make a significant contribution to achieving the UK Government's 10GW by 2030 target in a single region.

A key part of the project is Project Union and the plan to connect clusters using feeder pipelines. Feeder 7 is crucial for this study, where it is assumed that it will be converted to 100% hydrogen.

ECH_2 can utilise the existing natural gas assets of NGN, including existing natural gas storage and potential new hydrogen storage facilities, and build on the hydrogen production in two of the UK's largest industrial clusters in Teesside and Humber region and in turn ensure significant private sector investment in the UK's industrial heartlands.

ECH_2 is a 15-year programme that will be carried out in multiple discrete phases to decarbonise industrial processes and domestic heating in the East Coast region. NGN will look to trigger the OFGEM NZASP Re-opener to undertake the subsequent phase i.e., FEED study.

1.1 Purpose of the Document

The purpose of this EJP is to act as a signposting document to other reports that provide the engineering evidence required as part of the NZASP re-opener. It contains and expands the narrative provided in Sections 5 and 6 of the re-opener document.

2 Summary Table

Table 1.East Coast Hydrogen Summary Table

Name of Project	NGN East Coast Hydrogen FEED		
Scheme Reference	NGN Regulatory reporting pack		
Project initiation year	2024		
Project close out year	2027		
Total Funding requested for FEED not required in Guidance]	See Appendix A23		
Total Installed Cost Estimate	See Appendix A6		
Cost Estimate Accuracy (FEED Study)	See Appendix A23		
Project Spend to date	Pre-FEED study funded via Use it or lose it mechanism. FEED funding hasn't been spent		
Current Project Stage Gate	Completion of Pre-FEED		
Reporting Table Reference	TBC		
Outputs included in GD2 Business Plan	No		
Spend Apportionment	GD2	GD3	GD4
	TBC	TBC	TBC

3 Project Status and Summary

The East Coast Hydrogen project can be thought of as a programme of projects rather than an individual project in and of itself. NGN seeks here to fully address the guidance, however, there are elements of the EJP guidance that may be better suited to a specific project, which may even be post FEED.

NGN commissioned a consultant to undertake a Pre-FEED exercise. This work has now concluded. The Pre-FEED has resulted in the development of the following:

- A tentative route to transport and distribute the hydrogen gas.
- A programme plan for the FEED stage and
- An understanding of the costs of the FEED stage of the programme.

The funding requested through this re-opener submission is to undertake FEED and further Pre-FEED of some areas where the Pre-FEED study could not be undertaken. The funding details is mentioned in Appendix A 23. The funding requested is not to undertake capital delivery but to undertake a FEED study. Capital Delivery in future would be subject to further requests for an application to the Hydrogen Business Model for Transportation and Storage.

The Pre-FEED work to date includes:

- **Stage 1a** – Information gathering – Determined the production, demand, and storage profiles of hydrogen.
- **Stage 1b** – Optioneering Preparation – Set out the re-purposing strategy and identify the options available to transport and distribute hydrogen.
- **Stage 2** – Optioneering – Model and assess the different gas network pipeline cluster scenarios.
- **Stage 3** – Preferred Solution – Determined the preferred solution cost, delivery, and phasing plan.
- **Stage 4** – FEED preparation – Outlining the FEED design facilities, capital cost and design pipeline.

NGN has mobilised the necessary resource and budget to deliver this project. Engagement from board level and senior members of staff has been sought throughout the Pre-FEED stage of the project to ensure that the plans are in conjunction with the wider business strategy and commitments.

Philosophically, NGN propose repurposing its network for the transportation of hydrogen rather than constructing new assets. Summaries of the detailed assessments of various clusters are described in Section 6 of this document with further detail provided within the options study report.

4 Problem & Opportunity Statement

4.1 Project Purpose

The Government has set the target of decarbonising the power sector by 2035 and achieving net zero emissions by 2050. NGN owns 36,000 km of natural gas distribution pipework and wish to show the feasibility of much of their assets being transitioned to a hydrogen for energy distribution system with the prospect of contributing to meeting the Government's Net Zero Strategy.

The aim of this project is to deliver a FEED showing how the largest users (producers, storage companies and consumers) of a hydrogen network in NGN's licence area could be connected to NGN's network.

Failure to create a hydrogen network will make it challenging to de-carbonise the industrial and power sectors. Royal Society and National Infrastructure Commission suggested that hydrogen is essential for decarbonising the power sector. Without decarbonising the power sector, it will be challenging to decarbonise the domestic heating sectors with electricity and natural gas only.

4.2 Potential for Future Deviation

The need or options for the project will change under the following circumstances:

1. Project Union delays the finalisation of their routing options or deviate from the current options.
2. A private network fails to deliver or refuse to invest in their new-built pipeline as part of hydrogen production facilities.
3. The details of the Transport and Storage Business Model
4. Spurs may need to be added or omitted to or from the existing design should the end users choose to opt in or out of hydrogen use at a later stage.

The current design of NGN's hydrogen network is based on the Project Union's feeder 7 as the backbone of the transmission system in the NGN's area. If Project Union changes their routing option during the FEED period, NGN's current design and option will change accordingly. The current network hydrogen network is designed in such a way that if Project Union deviates from feeder 7 as their transmission system to some other feeders, the impact on the NGN hydrogen network will be minimal.

Similarly, Project Union's transmission routing from Asselby towards and around Humber region is yet to be finalised. Once this route is finalised, minor modifications on NGN's network are required to connect the distribution system into the transmission system.

NGN's new hydrogen network design is dependent on and connected to third-party private networks like [redacted] Teesside. Should those private pipelines not materialise, NGN's network will be impacted and will need re-designing in those areas.

Even though the design for the hydrogen network is established at this stage, the engineering decisions may change, and the network may need re-designing once the Transportation and Business Model is finalised.

During the FEED stage all the points raised above will be reviewed again, and final routing will be established.

4.3 Scope and Related Projects

The NGN ECH_2 FEED project is part of the overall East Coast Hydrogen programme in collaboration with NG and Cadent Gas. NG's ECH_2 project forms the first phase of Project Union. NGN and NG's ECH_2 FEED projects are integral to each other, i.e., for NG to repurpose the proposed feeders for hydrogen, NGN must remove their current natural gas off takers and modify the existing natural gas network to accommodate this. NGN are reliant on the NG Hydrogen Transmission pipelines to facilitate the associated distribution connections.

Other projects that are related and relevant to the ECH_2 project that have or will supply the Engineering and safety evidence to the ECH_2 FEED projects are:

- Future Grid led by NG.
- LTS Futures led by SGN.
- LTS Futures E1: Trial Design led by SGN.
- LTS Futures E1: Hydrotest completion report for Grangemouth to Granton pipeline illustrating integrity for live trial led by SGN.
- LTS Futures E2: Laboratory material testing led by SGN.
- LTS Futures E2: Laboratory testing: Grangemouth to Granton pipeline determine failure points with hydrogen led by SGN.
- LTS Futures E3: Offsite testing led by SGN.
- LTS Futures E3: Vent testing led by SGN.
- LTS Futures E3: Hot works testing (offsite testing) led by SGN.
- LTS Futures E3: Pipeline fatigue studies led by SGN.
- LTS Futures E3: PRS Testing led by SGN.
- LTS Futures E3: Vibration testing led by SGN.
- LTS Futures E3: Burst and fatigue testing led by SGN.
- LTS Futures E4: Live trial led by SGN.
- LTS Futures E4: Capacity assessment test plan for Grangemouth to Granton pipeline led by SGN.
- LTS Futures E4: Hot works testing (live trial validation) led by SGN.
- LTS Futures E5: QRA and Case for Safety led by SGN.
- LTS Futures E5: QRA Grangemouth to Granton pipeline for 100% hydrogen led by SGN.
- LTS Futures E5: Case for Safety-Grangemouth to Granton pipeline led by SGN.
- LTS Futures E5: "Case for Safety-Grangemouth to Granton pipeline" and "Management of Change process for applying repurposing blueprint to live trial" led by SGN.
- LTS Futures E5: Desktop emergency response simulation led by SGN.
- LTS Futures E6: Knowledge dissemination led by SGN.
- LTS Futures E6: Training and competence led by SGN.
- LTS Futures E6: Case studies LTS pipelines led by SGN.
- LTS Futures E6: Blueprint for repurposing led by SGN.
- Commercial framework for a (100%) H2 transition led by NG.
- Hydrogen Ready Components Phase 3 led by NGN.

The listings are not exhaustive and there are many other on-going projects from which the learnings can be implemented to the FEED stage of the ECH_2.

4.4 Project Boundaries

The ECH2 programme is wider and includes elements of Cadent and National Gas's networks. The project boundaries for ECH2 from NGN's viewpoint will be as follows:

- The hydrogen network considered will be within the NGN's Network area.
- The network pressure boundary is up to class 300 ratings.
- The project time considered is up to 2037. Further roll-out to be considered will go beyond 2037.
- The users considered are top industrial, large commercial and power users.

5 Project Definition

The aim of the FEED scope of the project is to develop a detail of the project to a level and cost certainty to allow a final investment decision to be made under the Transport and Storage Business Model.

The aim is to also demonstrate to DESNZ a solution to decarbonise the largest industrial and commercial customers by re-purposing NGN's existing assets wherever possible.

The goals of the FEED stage and concurrent Pre-FEED are:

- To develop a feasible network connecting supply, demand, and storage.
- To enable the decarbonisation of multiple hard-to-abate sectors.
- Support the UK government in achieving low-carbon hydrogen and net-zero targets.
- Provide system resilience and flexibility to the UK energy system.
- To catalyse wider system benefits.
- Inform a final investment decision and a methodology to deliver the project.
- Optimise the Return on Investment (ROI) by further optimising the network.
- Improve safety outcomes.
- Enable future application after the Transport and Storage business model is finalised.
- Ensure the proposed solution is in co-ordination with Project Union and third-party pipelines.

To achieve the above-mentioned goals, the key objectives are:

1. Confirm the existing demand, supply and storage data is still correct and update where required.
2. Further assess the technical viability of the proposed pipeline routes and further optimise routing corridors to determine final routing. If multiple routes are possible, a cost benefit analysis should be carried out before determining the final routing.
3. Undertake pipeline design and safety assessments.
4. Develop designs for the repurposing/development of the required Above Ground Installations (AGIs).
5. Progress the consultation and environmental assessments of each route and AGI.
6. Determine project costs to an AACE class 3 estimate to inform final investment decision.
7. Determine sequence of development and proposed delivery programme.
8. Develop packages to tender Engineering, Procurement and Construction (EPC) contracts to deliver the network.
9. Coordinate with all project stakeholders.

The project scope consists of new and re-purposed pipelines with operating pressure ranging from high pressure (HP) to intermediate pressure (IP) and medium pressure (MP).

The scope also involves front end engineering and design of various pressure reduction installations (PRI) and off-take connections. The PRIs are also classed as new and re-purposed along with the off-take connections.

5.1 Supply and Demand Scenario Discussion and Selection

The detail of this scenario is discussed in the Need Case Paper.

5.2 Project Scope Summary

For effective delivery within stipulated timescales, the FEED scopes are split into different packages.

The packages are:

- Project Management Package
- HP / IP Package
- MP Package
- Pre-FEED Package
- Consultation,Consenting and Environmental Package

In addition to the above packages, NGN will also provide a close-down report on the outcome of the FEED study as per Section 5.2.7 below.

5.2.1 Project Management Package

The project management (various projects) stream will work as a central hub to drive the project delivery, overseeing the deliverables of other project packages.

This package is further divided in other management services:

- *Project Services*: to initiate planning, execution, controlling and closing the work of other packages and management services.
- *Design Management Services*: to look after the engineering design produced by other technical consultants like HP / IP Package, MP package, Consenting and Environmental package and the Pre-FEED Package.
- *Commercial Management Services*: to ensure that the Commercial Proposal is robust and as accurate as possible, based on the current information to hand, and ensuring that NGN has competently evaluated market options available. Ensuring the Commercial proposal is robust is essential to ensure the right level and quality of resource is engaged on the Project to drive value for money and risk mitigation.
- *Stakeholder Management Plan*: to engage with users, producers, and storage providers of hydrogen and establish commitment to integration with the network.
- *Network Analysis*: Carrying out a detailed analysis of the new hydrogen network and the existing natural gas network to ascertain the flow assurance of both hydrogen and natural gas.

5.2.2 HP/IP Package

In the Pre-FEED, a network has been developed based on re-purposed and new built pipelines. The pipelines have pressure ratings from high pressure (more than 7 barg) to Intermediate pressure (2 barg to 7 barg) and medium pressure (75 mbar pressure to 2 barg).

For the engineering design delivery, the high pressure and intermediate pressure infrastructures are grouped together for the design purpose and medium pressure infrastructure are kept in a separate group for the ease in design. This is because the design standards and specifications will be different for both these groupings.

This package involves the scope of FEED work for the HP / IP infrastructure.

This package of works shall progress the FEED design of the sites and pipelines to a point at which a single option has been selected for each AGI or pipeline and the works can be accurately costed to AACE class 3 estimates for final investment decision and to tender for EPC contracts.

The scope of this package will include the engineering and design of:

- Enabling Project Union re-purposed pipeline – this involves disconnecting existing offtake connections from the Feeder 7 and connection to new natural gas feeders.
- Building new natural gas HP/IP pipelines and AGIs to enable re-purposing of existing NG pipelines and new build pipelines for hydrogen transportation.
- New and repurposed HP and IP pipelines.
- New, modified, and repurposed HP and IP AGIs including pressure reducing stations and block valve stations.

The details of the deliverables in the package can be found in Appendix A22 – FEED Study Scope Report.

The summary and brief description of pipeline infrastructure requirements within this scope can be found in Table 2 of Appendix A22 – FEED Study Scope Report.

The summary and brief description of above ground installations infrastructure requirements within this scope can be found in Table 3 of Appendix A22 – FEED Study Scope Report.

5.2.3 MP Package

This package involves the scope of FEED work for the MP infrastructure which is not captured in the HP / IP infrastructure package.

This package of works shall progress the FEED design of the sites and pipelines to a point at which a single option has been selected for each AGI or pipeline and the works can be accurately costed to AACE class 3 estimates for final investment decision and to tender for EPC contracts.

The scope of this package will include the engineering and design of:

- New and repurposed MP pipelines.
- New, modified, and repurposed MP AGIs including pressure reducing stations and block valve stations.

The summary and brief description of pipeline infrastructure requirements within this scope can be found in Table 5 of Appendix A22 – FEED Study Scope Report.

Other than the above AGI, it has been envisaged that MP to LP (Low Pressure) governor stations may be required at the customer premises depending on their pressure requirements.

5.2.4 Pre-FEED Package

The scope of this package is similar to the Pre-FEED study that has already been undertaken, but extended to cover the following geographical areas:

- Cumbria
- North Tyneside
- Other regions where the Pre-FEED study could not be completed at this stage

The details of the scope for this package can be found in Appendix A22 – FEED Study Scope Report.

5.2.5 Consenting and Environmental Package

This package will be divided in two sub-packages to support the engineering studies and the planning permission / DCO requirements etc. and carry out the necessary environmental impact assessments.

The aim of this package is to:

- Carry out all the survey works required to complete the engineering studies or capture the same which is necessary for the detailed design stage.
- Develop the planning and consenting works to a desired level to align with the FEED which will allow the overall project delivery schedule, including the EPC stages.
- Set out the approach that is to be followed while undertaking the environmental impact assessment (EIA) of the pipelines.
- Summarise the key stages that are to be followed in line with the statutory requirements and formal advice provided by the planning inspectors.

The environmental assessment will follow the process of compiling, evaluating, and presenting environmental information about the likely significant environmental effects, both adverse and beneficial, of the project. The assessment will be designed to help produce an environmentally sympathetic scheme to provide decision makers and statutory consultees with the environmental information they require during determination of an application for consent.

The pipelines and AGIs to be assessed are detailed in Appendix A22 – FEED Study Scope Report.

5.2.6 Final Pre-FEED Study Package

The Pre-FEED study initially collated information to inform the network development. This included production, demand, and storage figures. This data was then further validated by stakeholder engagement which ran throughout the project, to further strengthen the understanding of the network requirements.

The project design basis was developed to understand the technical constraints, while creating the new hydrogen network.

The route optioneering phase of the Pre-FEED study aimed to understand the viable pipeline connections which could be made between the production sites, storage, and users. The routing was undertaken using an Artificial Intelligence routing tool, which considered multiple technical and environmental constraints as well as developing complexity scores and capital costing for each pipeline.

Ensuring that there was continuity of a natural gas supply where required, was another key aspect of this project. Network analysis was undertaken to verify this was achievable through the proposed network, allowing for reinforcements by new-build pipeline where it was not achievable.

Outline designs of pipelines and AGIs were created to understand the key differences between natural gas and hydrogen transport infrastructure. This also informed the capital cost estimations which utilised NGN construction experience to develop costings.

The project concluded by outlining the next steps which would be required during the FEED stage of the project and developing a scope document and programme of how this would be delivered.

The details of the final Pre-FEED study can be found in Appendix A21 – Pre-FEED Report.

5.2.7 Close-down Report

The close-down report will detail all the conditions or instances where the FEED study has deviated from the objectives agreed in this document. NGN will set out justified reasoning for all of the conditions or instances that have not been made.

NGN will also return monies which will not be spent during FEED stage with a justification detailing why the section cannot be completed in the FEED stage.

5.2.8 ECH_2 Project Phasing

The overall ECH_2 project depends on different stakeholders like the hydrogen producers, storage companies, Project Union, and the local distribution companies (NGN, Cadent).

Project Union will connect hydrogen production, storage, and demand to enable net zero and empower a UK hydrogen economy. Repurposing existing transmission pipelines will create a low-cost hydrogen 'backbone' for the UK by the early 2030s and connect to the proposed European Hydrogen Backbone.

In the Pre-FEED stage, Project Union has identified the pipelines that would be re-purposed for hydrogen transmission.

To connect all the stakeholders, the NGN part of the ECH2 project has defined the following project phases:

Network Phase 1 – Production Project Development

In this phase the production plants and the development of private network are considered. The production plants classified as blue or green hydrogen production plants depending on the processes by which the hydrogen is produced. The Blue and Green hydrogen have different pipeline network. The detail of the production plants can be found in the Production Report.

Figure 1. Map showing the location of announced hydrogen production projects in the ECH2 region.

Network Phase 2 – Hydrogen Transmission Development

The Project Union team are working to facilitate repurposing of parts of the existing NTS assets for use with hydrogen. Works involved in enabling Project Union will include modifications to offtakes from repurposed feeder pipelines and construction of new offtakes from existing natural gas feeders where required.

Figure 2. Map showing the first leg of Project Union in purple, which is to act as the transmission backbone for ECH2.

Network Phase 3 – Hydrogen Distribution Development into main industrial clusters

In this phase, the development of NGN's network for hydrogen is considered from the Project Union enabled feeders or new lines.

Extension to other users through private network is also considered in this phase.

The initial concept is to create main industrial clusters in three areas as follows:

3a – Teesside

3b – Humber region

3c – West Yorkshire

3d – North Yorkshire

3e – South of Tyneside

Figure 3.Map showing the ECH2 network.

Network Phase 4 – Distribution Hydrogen Area Roll Out (Optional)

Phase 4 has been designed to support the roll-out for hydrogen for heat if a positive decision is made in 2026. The network has been developed to facilitate this at the LTS level, whilst ensuring routing is viable based on the industrial and commercial connections identified, to ensure project resilience. The hydrogen network is independent of the domestic heating network, but it is designed in such a way that if the Government decides hydrogen as a carrier of domestic heating network, then the domestic heating network can be expanded from the East Coast hydrogen network with minor modification.

Network Phase 5 – Hydrogen Network to areas away from main clusters

It was not possible to connect all the users in Stage 3 of the project due to unavailability of hydrogen backbone or production facilities. Stage 5 considers exploring all these areas as a Pre-FEED stage and creating a robust network.

These areas include Cumbria, North of Tyneside, areas of East Yorkshire and other users who are far away from the hydrogen transmission and distribution backbones.

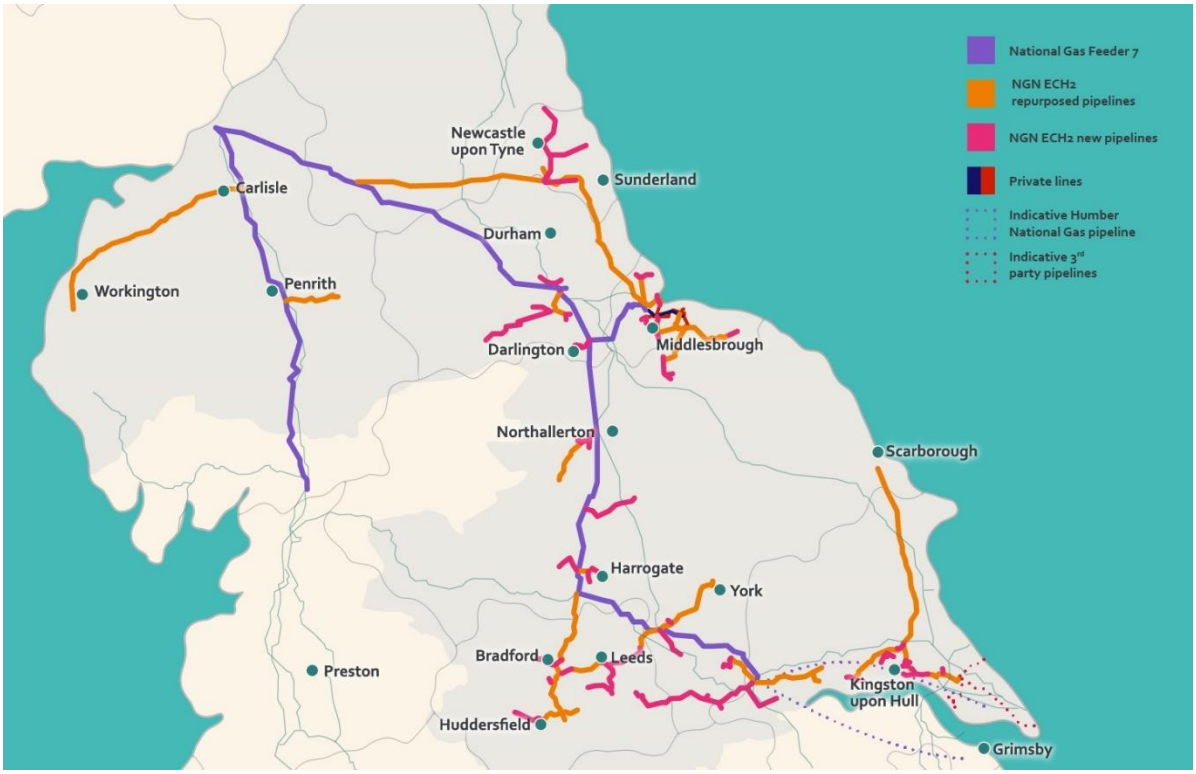

Figure 4. Map showing the expansion of ECH2.

6 Options Considered

The main focus of Pre-FEED was on supplying the largest I&C and Power natural gas users with hydrogen from the production and storage facilities. The first approach to achieve this was to establish a High-Pressure Transmission line backbone through the NGN area. In collaboration with National Gas (NG), it has been established that the existing feeder 7 from Bishop Auckland / Cowpen Bewley to Asselby via Pannal and Towton can be re-purposed for hydrogen transportation.

Once the transmission backbone was established, suitable supply points and the off-take points were confirmed. With the supply and off-take points confirmed, various hydrogen supply options were identified, and each option was evaluated using multi-criteria analysis. After the analysis the preferred option was selected.

During this selection process, priority was given to re-purposing existing pipelines wherever possible.

While re-purposing some of the existing pipelines, a new natural gas network was proposed to reach the town areas where building a new hydrogen network doesn't seem possible.

Once the draft hydrogen network was created, it was plotted on Google Earth along with the largest I&C and Power natural gas users. The existing network (High Pressure, Intermediate Pressure and Medium Pressure) was also plotted on Google Earth.

A final analysis was carried out on further re-purposing of the existing pipelines to transport hydrogen, connecting the production and storage facilities with the users.

The detail of the optioneering and phasing study report can be found in Appendix A20 – Options and Phasing Study Report.

The transmission backbone for Cumbria and North Tyneside was not established until later in the Pre-FEED stage of the project and so further development of a hydrogen network could not be established for these two regions. Additionally, not all of the largest users were connected in the Pre-FEED stage due to the complexity of the locations and distance from the core hydrogen network.

All the points raised in the previous paragraph will be subject to Pre-FEED during the proposed FEED stage of the project.

The definitions of the following terminologies used in the document throughout are explained below:

Repurpose – Repurposing refers to the utilisation of an existing natural gas pipeline and retrofitting it for hydrogen use.

The aim was to repurpose as much of the existing network as possible since this has a lower CAPEX compared to new-build pipelines. The project's approach to repurposing is detailed in the Repurposing Strategy report (293805-ARUP-RPS [5]).

Private – Private refers to the utilisation of privately owned pipelines.

Producers [redacted] are proposing to build their own distribution networks to users within the vicinity of their plants. This has been necessary for the producers to enable a robust business case in the absence of firm plans to develop any wider reaching network. It has been

assumed that certain producers' pipelines will be constructed as part of the network development undertaken.

New Build – New build refers to pipelines that need to be newly built.

Where pipelines could not be repurposed or private lines utilised, then new build piping has been assessed.

6.1 Do Nothing Option

The do-nothing option will result in the failure to decarbonise both the industrial and commercial sector and the domestic heating network. By choosing this option, the government's target of achieving net zero by 2050, would be impossible.

A further consequence of the do-nothing option will lead to the costly de-commissioning of the vast existing natural gas assets, whereas the existing assets can be re-utilised with minor modifications to create a new hydrogen network.

The do-nothing option will also not support or enable Project Union which sees existing transmission lines re-purposed to transport hydrogen to the Local Distribution zones (LDZs).

6.2 Do Minimum Option

The minimum option for NGN would be not to develop its network to support hydrogen transportation. This may lead to the development of duplicated private networks that are not interconnected, not supporting the UK Government's decarbonisation policies and targets regarding the establishment of a hydrogen economy.

As mentioned in the Needs Case, the Committee on Climate Change (CCC) is clear that not building a 100% hydrogen network would drive inefficiencies (e.g., in the location of assets or the volume of production and storage infrastructure required) and, in turn, increased system costs.

6.3 Market Based Option

Currently there are no practicable market-based options available for consideration. Market-based options may be appropriate where a network operator is considering reinforcing a network to address a peak in demand. However, in this case, the proposal is to develop an entirely new set of assets for hydrogen transportation. Market-based options will continue to be considered through the FEED.

6.4 Delaying Proposed Work Option

Although the RIIO-2 price control was finalised before ECH_2 could be incorporated. Delaying ECH_2 to the following price control could significantly impede the attainment of the UK's net zero targets. ECH_2 is required to enable other major UK hydrogen project infrastructure, linking Teesside and Humber industrial clusters, and connecting 5.6 GW hydrogen production capacity to gas users and storage in the North-Eastern and Yorkshire regions.

Further to this, with the announcement of the Transport and Storage Business Model and the associated timelines, delaying the FEED means that the government's set window for a hydrogen network to come online between 2028 and 2032 would be missed for the northeast of the UK.

6.5 Selection Process of Working Options Considered

After the selection of the transmission backbone and establishing the infrastructure and connection points, the NGN region was split into six areas for assessment:

- Teesside
- Bishop Auckland to Pannal
- Leeds / Bradford
- Towton to Asselby
- Humber
- Tyneside

Within these geographic areas, the producers, storage sites and users were grouped in clusters to develop the new hydrogen network.

6.5.1 Consideration of Options

The following options were considered while developing the new hydrogen network in each area.

The detail of the optioneering and phasing study report can be found in Appendix A20 – Options and Phasing Study Report.

Re-purposing of existing pipelines:

The primary aim is to repurpose as much of the existing network as possible, as this has an average of 20% lower Capital Expenditure than new-build pipelines and would provide less disruption to the public. To initially assess feasibility, a repurposing assessment was undertaken to establish if the chosen route had sufficient capacity to provide hydrogen to the identified users. Where this was acceptable, the routes were then modelled further to assess the impact on the existing natural gas network and determine the work required to separate the line to be repurposed.

Private Pipelines:

As part of the hydrogen business model funding, low-carbon hydrogen producers must build their own distribution pipelines to supply customers. This has been necessary for the producers to develop a robust business case without a wider-reaching hydrogen network. Throughout the project, NGN has engaged with these producers to ensure no duplication occurs between the routes that NGN and producers take. Furthermore, discussions have taken place on how these private lines could connect to ECH$_2$. Later stages in the development of the hydrogen transport and storage model will clarify ownership and operation of these private lines.

Newbuild Pipelines:

Building new licensed pipelines has been considered when pipelines cannot be repurposed, or private lines cannot be utilised.

6.5.2 Network Modelling

Network modelling for the proposed hydrogen network will be carried out in the FEED stage. To enable the re-purposing of some of the existing pipelines, network modelling was completed during Pre-FEED for the existing natural gas network and where necessary a new natural gas network was developed.

The details of the network modelling can be found in Appendix A17 – Network Modelling Brief.

6.5.3 Routing Option Analysis and Scoring

The optioneering stage aimed to develop and assess the feasibility of the routes to connect the producers, network feeders (NG), potential storage and the users within NGN's area of the ECH_2 project.

The methodologies adopted to develop the hydrogen network are as below:

1. Geographical assessment of producers, users, and storage
2. Identification of probable routing areas
3. Establishment of industrial clusters for development
4. Identification of scenarios based upon key decisions
5. Formation of the constraints to routing
6. Iterative routing of pipelines

Upon development of clusters, different routing options were created linking producers, users, and storage providers. These options were analysed in more depth to understand the viability, cost, and construction time of each pipeline so that the network clusters could be evaluated.

Continuum's Optioneer™ linear infrastructure routing tool was used. The tool considers route options via a constraint weighting and automated AI routing methodology that holistically considers constructability along with environmental and consenting criteria. This meant that routing options could be rapidly assessed, iterated on and analysed for metrics.

The AI tool was populated with GIS (Geographical Information System) layers representing the constraints to the routing. The data layers consisted of 117 separate datasets which cover aspects including:

- Sites of Special Scientific Interest
- Buildings
- National parks
- Electrical infrastructure
- Flood zones, etc

For each data layer, a technical and consenting penalty classification was assigned. This allowed the determination of technical and consenting penalties for the study area and the input was given to the AI tool to develop the routes. The build-up of the overall penalty for each route option was generated by the tool to establish the most efficient route.

The classifications were quantified in accordance with the following table.

Table 2.Classifications considered during routing option analysis.

Classification / ranking	Constraint type	Risk-based	Policy wording	Designation type
Class 5	Hard constraint	Likely to preclude development	No development	Depends on the specific objective
Class 4	Critical importance	Significant risk Significant impact	Avoid as far as reasonably practicable	Internationally and/or nationally designated
Class 3	High importance	Likely risk Significant impact	Avoid where possible	Regionally designated
Class 2	Medium importance	Likely risk Low impact	Reduce effects on	Locally designated
Class 1	Low importance	Insignificant risk Low impact	Avoid where possible whilst avoiding undue diversion	Non-statutory designation
Class 0	None - information only	No risk	Report on	For information only

With the tool populated with the layers and penalties, the required routing points were inputted, and multiple routes were created between each A to B point. They were assessed individually to ensure the tool was applying the criteria in the correct manner and that the routing was realistic.

After the routing was completed, a Multi-Criteria Analysis (MCA) was applied to analyse each option and an optimal solution was reached.

The details of the optioneering completed in the Pre-FEED stage can be found in Section 9 of Appendix A20 – Options and Phasing Study Report.

The MCA framework is shown in the table below.

Table 3. MCA Framework.

Criteria	Weighting	Low - 1	Low/Medium - 2	Medium - 3	Medium/High - 4	High - 5
Consenting	15%	No new consenting requirements	TCPA for AGI only - requiring engagement with single landowner.	TCPA for pipeline - requiring engagement with multiple landowners (some of whom agreements already exist for existing pipelines).	TCPA for AGI and pipeline - requiring engagement with multiple landowners (none of whom have agreements in place for existing pipelines).	Nationally Significant Infrastructure Project. Development consent order required (3-4 years)
Environmental Impact (human health and designated landscape, heritage, and nature sites)	20%	No or very low environmental impact, no sensitive area crossings - no environmental impact assessment required (Schedule 2 site not requiring env impact assessment).	Option goes through designated sensitive area(s) of local importance and meets the Schedule 2 thresholds. Limited Environmental impact assessment required.	Option goes through designated sensitive area(s) of regional importance and meets the Schedule 2 thresholds. Environmental impact assessment required.	Option goes through designated sensitive area(s) of national importance and meets the Schedule 2 thresholds. Environmental impact assessment required.	Option goes through designated sensitive area(s) of international importance e.g., European designated sites or world heritage sites and/or meets the Schedule 1 thresholds. Environmental impact assessment required.

Land interests and public perception/ safety considerations (separation distance).	15%	Very low impact on land interests and public perception. Separation distances for safety not constrained.	Low impact on land interests and public perception. Separation distances for safety not constrained.	Medium impact on land interests and public perception. Separation distances for safety minimally constrained.	High impact on land interests and public perception. Separation distances for safety constrained.	Very high impact on land interests and public perception (high pressure pipeline through a town e.g.). Separation distances for safety significantly constrained.
Constructability	15%	Minor refurbishment to AGI, no modifications to pipeline	Replacement of existing AGI, no modification to pipeline.	Replacement of existing AGI, refurbishments required to existing pipeline.	Minor refurbishments to AGI, new pipeline required.	Replacement of existing AGI, new pipeline required.
Total Installed Cost	20%	Total installed cost will be scored based on ranking of options. The utilisation factor of the lines will be factored into the cost and the scoring will be based on the order of magnitude of the cost in terms of £/MWh/annum.				
Security of Supply	15%	Hydrogen supply from repurposed NTS (offtake close to repurposed NTS) and natural gas supply as back up for full capacity. No compromise to other users of natural gas (e.g., domestic, or non-top 250)	Hydrogen supply from repurposed NTS with no natural gas back up supply (offtake far from repurposed NTS), as well as access to hydrogen production and storage sites allowing for buffer capacity.	Hydrogen supply not directly from repurposed NTS (no natural gas back up supply), with access to hydrogen production and storage allowing for buffer capacity for security of supply.	Hydrogen supply not directly from repurposed NTS but nearby access hydrogen and natural gas storage sites as a buffer.	Hydrogen supply not directly from repurposed NTS, with no buffer capacity from production, linepack, or storage and no natural gas supply as backup supply.

6.5.4 Description of Short-Listed Options

In each of the six geographical locations, referred to earlier, options for each of the new pipeline route corridors were developed and evaluated using Continuum Optioneer™ software to determine the optimal routings to include for each scenario.

The preferred options were then determined based on the lowest penalty and CAPEX.

Fully developed preferred options were then analysed using MCA (as described in the previous section) and the preferred options were selected.

6.5.5 Cost Benefit Analysis for Engineering Solutions

Continuum's Optioneer™ linear infrastructure routing tool has an added benefit of incorporating the CAPEX model. The tool applies different construction methods to each section of a route, dependent on the terrain or features it is running through and the complexity of these. Costs were assigned to each construction methodology in terms of fixed costs (for start-up, equipment etc.) and linear costs (for labour, materials etc) which enabled the build-up of CAPEX for each pipeline, which was also used in the route selection process. A diagram of the CAPEX model is shown in the figure below.

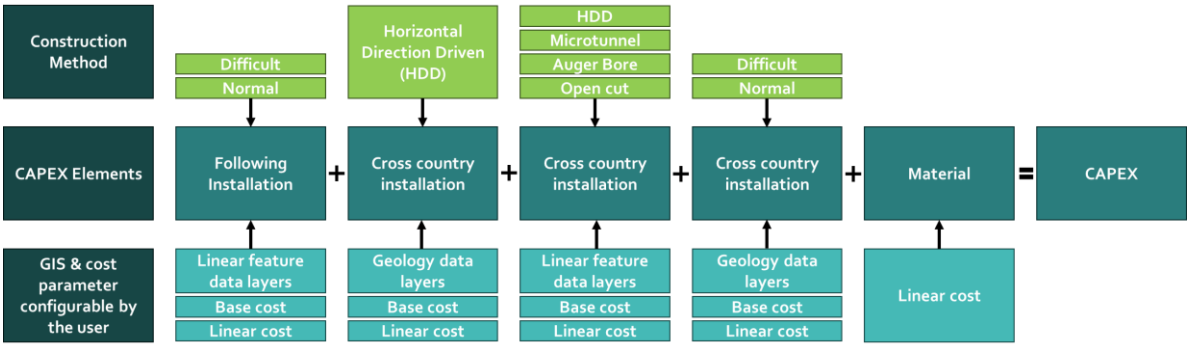

Figure 5. CAPEX Model Representation.

The details of the costing of the options can be found in Appendix A5.

6.5.6 Conclusion – Preferred Option

The routing thus developed from the various methodologies as explained in the previous sections were plotted on Google Earth. The new and re-purposed routes were further assessed against the existing natural gas pipelines for further re-purposing of the existing HP (High pressure) and IP (Intermediate Pressure) pipelines.

Throughout this process the focus on users has been based on the assessment of the I&C and power users connected to NGNs network. It was found more feasible to switch the supply of single users due to the upgrading and or modifications of the plant and equipment. However, there are instances where the routing connects to a single user which is in an area with multiple other industrial users close by, for example technology parks and industrial areas, but the demand of the other users has not been included. There is therefore an opportunity to further assess the potential demand in the clusters based on the additional users in close proximity. A map of preferred solutions from all scenarios is shown below.

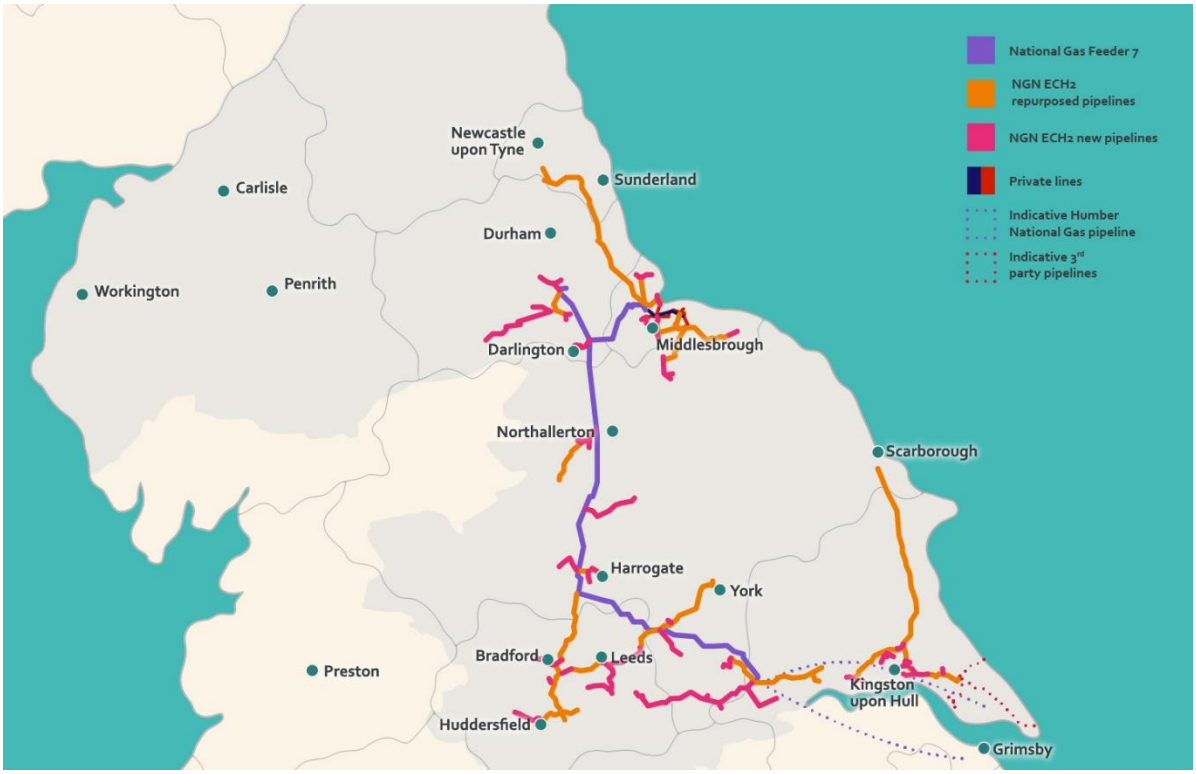

Figure 6. Final Routing Map.

The Cumbria and North Tyneside areas were not assessed at this stage as the repurposing of the national transmission system to hydrogen was not finalised. Other users in the core areas were also not connected at this stage as laying pipelines over long distances to reach them for a lower demand was not deemed economically feasible.

A further Pre-FEED study (within FEED stage) is required for all discounted areas as discussed above to develop a detailed network within those regions.

At the end of the current Pre-FEED stage as the design stands, the hydrogen network will have:

- 285km of HP pipelines out of which 203km of pipelines will be re-purposed (71.2%)
- 77km of IP pipelines out of which 24.6km of pipelines will be re-purposed (46.9%)
- 203km of MP pipelines out of which 11km of pipelines will be re-purposed (5.4%)

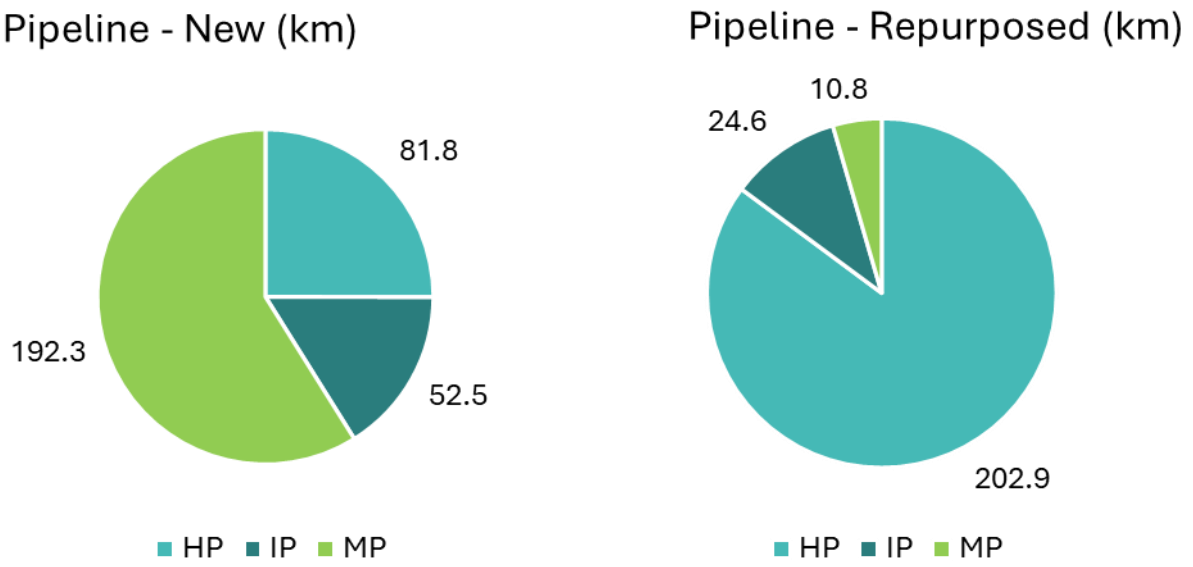

Figure 7. New vs Re-purposed Pipelines.

6.5.7 Options Cost estimate

Once the clusters had been developed (as described in Section 6.5.3), different routing options were created linking producers, users, and storage providers. These options were analysed in more depth to understand the viability, cost, and construction time of each line so that the network clusters could be evaluated.

The routing options between two points were considered and evaluated via the Continuum's Optioneer™ linear infrastructure routing tool as described in the Section 6.5.3.

6.5.8 Options Summary Table

The EJP guidance states that applicants should provide a summary of the options considered. This appears reasonable for single projects, for example, the development of a single pipeline or means of transporting hydrogen from point A to Point B. However, as highlighted above, ECH2 is a programme and each cluster itself has multiple options which have been considered. Details of all of the routes considered can be found in Appendix A20 – Options and Phasing Study Report.

The CAPEX model of the Continuum software has captured the cost of building a pipeline from point A to B for various routing options. The output from the Continuum software is attached in Appendix A5 – Continuum Options Cost Estimation.

6.5.9 Summary of Project Cost and Phasing Plan

6.5.9.1 Summary of Costs

The project cost summary is outlined in the table below. This is expanded upon in Appendix A6 – Indicative Project Cost Report.

Table 4. East Coast Hydrogen Installed Cost Estimates.

DIRECT COSTS		
Area		**Cost (Million GBP)**
Teesside		[redacted]
Bishop Auckland to Pannal		
Leeds / Bradford		
Towton to Asselby		
Humber		
Tyneside		
TOTAL DIRECT COST (TDC)		
INDIRECT COSTS		
Item	**% of TDC**	**Cost (Million GBP)**
FEED & Detailed Design	[redacted]	[redacted]
Project Management		
Commissioning		
TOTAL INDIRECT COSTS (TIC)		
Contingency		
Total CAPEX		
		Cost (Million GBP)
TOTAL CAPEX (TDC + TIC)		[redacted]

6.5.9.2 Phasing Plan

Figure 8 below shows a summary of the phasing plan, outlining the expected dates for connection of individual clusters defined in Appendix A6 – Indicative Project Cost Report along with the expected supply and demand, and the installed pipeline length.

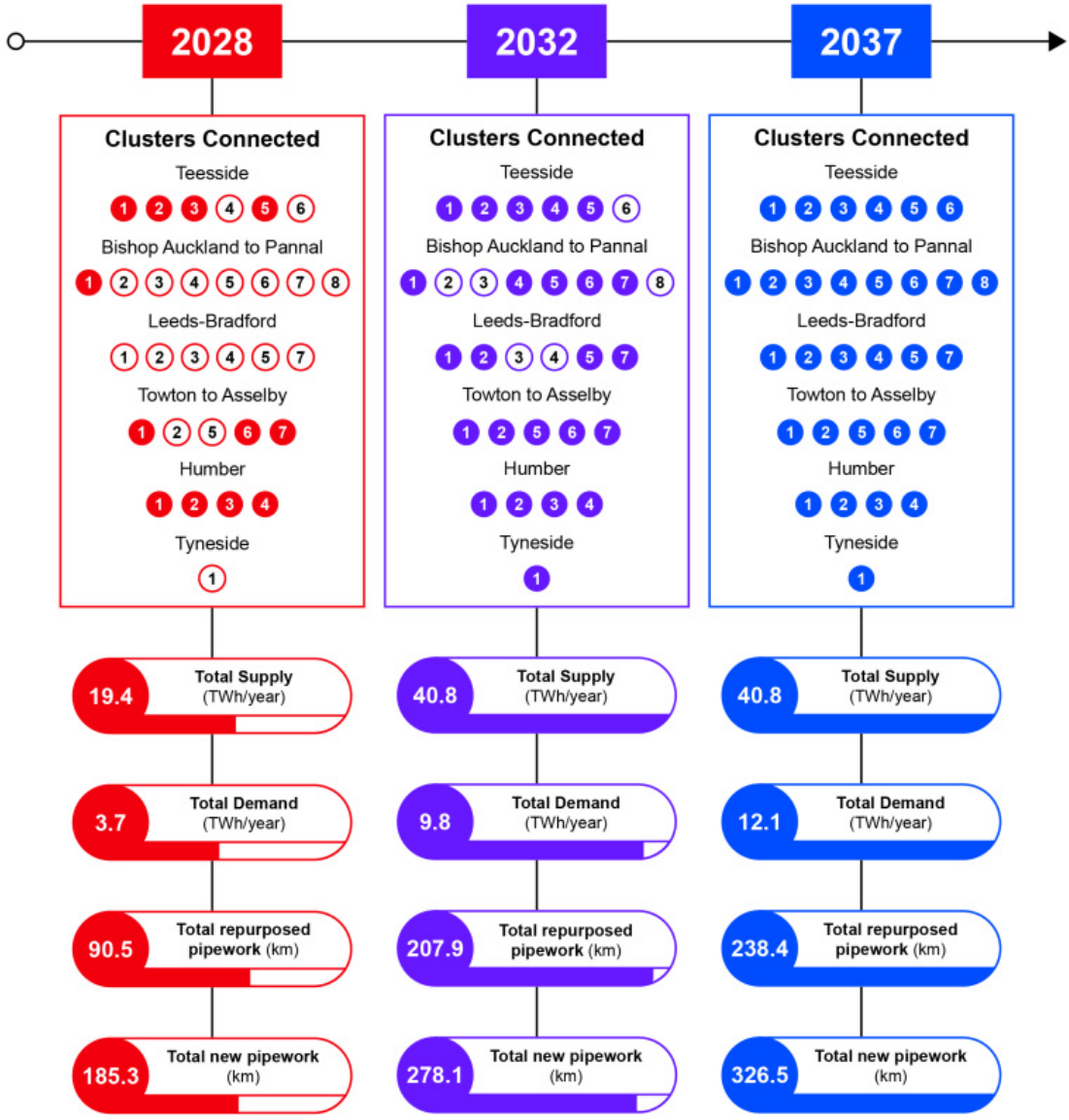

Figure 8. Phasing Plan Infographic on Pre-FEED Completion.

Further information on the phasing plan can be found in Appendix A21 – Pre-FEED Report.

6.5.10 Further Development to ECH2 Network

To ensure alignment with developing private hydrogen lines, NGN has met regularly with hydrogen producers.

[redacted]

[redacted].

[redacted].

[redacted]

[redacted].

[redacted]

[redacted]

[redacted].

6.5.10.3 Asselby to Hull

NG has not yet produced a solution to connect from Asselby to Hull in the transmission network. If the transmission network solution isn't designed within a reasonable timeframe, NGN has developed an option to connect between Hull and Asselby via the regional distribution network.

The option to connect Asselby to Hull would involve a new 23km HP pipeline from Asselby AGI that would have a hydrogen feed from feeder 7, this would connect to NGN's existing HP 1050 steel pipeline that is to be repurposed for hydrogen.

Figure 12. Asselby to Hull Route Map.

7 Business Case Outline and Discussion

NGN is stepping in to achieve an energy transition from natural gas to a sustainable transporter of net zero energy, hydrogen. To do this, NGN is developing an investable solution for a hydrogen transmission and distribution network which will supply low carbon hydrogen to I&C customers in the NGN region.

Not progressing the East Coast Hydrogen FEED will remove the opportunity to develop a regional and national hydrogen network that is a key element of the UK's Hydrogen and Net Zero strategies.

A hydrogen network will allow industrial energy users to have confidence that a suitable form of net zero energy will be available to them, encouraging them to make investment decisions in the UK.

The FEED study will provide an agreed mechanism to manage the uncertainty that remains around the details of the transport and storage business model, the outcome of National Gas (NG) options and the investment decisions by key hydrogen producers and storage companies.

A timely approval i.e., within four months of submission will allow the FEED stage of the project to achieve alignment with the DESNZ transport and storage model and proposals.

7.1 Key Business Case Drivers Description

Key business case drivers are:

1. The decarbonisation strategy sits well within NGN's sustainability statement.
2. NGN already has an existing natural gas network and transitioning the energy distribution from natural gas to hydrogen can maximise the use of these existing assets.
3. The new Transportation and Storage Business Model has the potential to ensure long term operation and stability for NGN.
4. To be part of a significant energy transformation innovation project.

7.2 Supply and Demand Scenario Sensitivities

The first stage of FEED will be to engage the producers and consumers and a cost benefit analysis will be carried out depending on the users' requirements and producers' capability. During this engagement, some of the spurs for the users may change and or new spurs will have to be designed to re-modify the hydrogen network.

The network might experience a minor modification while connecting to private network which will be the outcome of the engagement session.

7.3 Business Case Summary

The goals of the FEED stage and concurrent Pre-FEED are to:

- Develop a feasible network which connects supply, demand, and storage.
- Enable the decarbonisation of multiple hard to abate sectors.
- Support the UK government in achieving low carbon hydrogen and net-zero targets.
- Provide system resilience and flexibility to the UK energy system.
- To catalyse wider system benefits.
- Inform a final investment decision and a methodology to deliver the project.
- Optimise the Return on Investment (ROI) by further optimising the network.
- Improve safety outcomes.

- Enable application to the anticipated Transport and Storage Infrastructure allocation round.

7.4 Benefits and Limitations

The benefits are:

1. Support the Government's decision to achieve the Net Zero by 2050.
2. Decarbonise the I&C and Power sectors in NGN's Geographical Area.
3. To prepare a detailed information on final investment.
4. Utilise NGN's existing assets to transition from natural gas to hydrogen.

The key limitations are:

1. The Transport and Storage Business Models are yet to be finalised.
2. Dependencies on Project Union routing options.
3. Dependencies on private network routing options.

8 Preferred Option Scope and Plan

The preferred option or scenario for each cluster is set out in Appendix A20 – Options and Phasing Report.

The project scope is detailed in Section 5.2 above.

8.1 Preferred Option for this Request and how it meets the Problem Statement

The preferred option is detailed in the Section 6.5.6.

The preferred option creates a network in line with the Network Pathway Policy connecting the producers, storage and the top I&C customers and power sectors. The most cost-effective solution in the Pre-FEED study has been achieved by re-purposing more than seventy percent of the existing HP pipelines.

The final route will be finalised during the FEED study after further engagement with Producers, storage companies and existing large users.

8.2 Project Spend Profile

The cost of undertaking the FEED is set out in Appendix A23 – FEED Cost Report. The spend Profile is detailed in section 7.5 of the re-opener document.

8.3 Efficient Cost

The main cost driver for the FEED study which is the next stage of the project is the scope of works which are detailed in Section 5.2.

From the scope of work, the detailed work breakdown structure was created and assigned to the packages. The project management package includes specific activities that will be self-delivered by NGN e.g., network modelling, stakeholder engagement etc. The rates used for the activities in the project management are the rates of the actual staff members. Where external resources are required to complete a specific task or activity for the project management package, tendered framework rates like professional service framework rates were used.

The durations for the project management package were based on the project delivery plan which is detailed in appendix A24. The durations are considered to be efficient based on the plan.

The other packages like HP/IP packages, MP package, Pre-FEED package and Consenting, Environmental Package were costed by competent consultants who are under NGN's design service framework. The consultants derived the final cost based on the work-breakdown activities from the work scopes. The details of the costing are provided in Appendix A23. The rates used by the consultants are the agreed rates with NGN procurement team. The cost is considered to be efficient for this purpose.

ECH_2 is an innovative project with creation of a new hydrogen network, and the only benchmark found to support this project are the construction of new AGIs and pipeline for natural gas in the past.

All the costs were thoroughly checked by the different departments within NGN and cross checked by the consultants.

Since this stage of the project is FEED study, the involvement of procurement is minimal and expected to be more towards subsequent stages and the completion of the project.

8.4 Project Plan

NGN is submitting this NZASP Re-Opener Licensee application at the end of Q1 2024, anticipating that the detailed assessment phase will take place through Q2 2024 and that Ofgem will make a re-opener funding decision by the start of Q3 2024.

NGN intends to divide the FEED into five packages aimed at ensuring the expertise available is focused in the relevant area. The packages will be as follows:

- Project Union Enabling Works
- NGN HP/IP Package – The Core NGN Hydrogen network
- NGN MP Package – Spurs to reach industrial clusters
- Consultation / Survey Package - Supporting all other packages
- Pre-FEED of Newcastle, Cumbria & other industrial customers – The wider roll out

During the period between this submission and the subsequent funding decision, NGN will continue engaging with the producers, storage suppliers and end users to ensure continued support for the Project. NGN will also begin to engage with the FEED, Environmental & Planning Consulting Markets to enable the Tendering/Contracting Phase to commence immediately, should a positive funding decision be reached

NGN recognises that a significant factor in delivering the NGN Core Hydrogen Network, while maintaining parts of the existing Natural Gas Network, is the reliance on National Gas Transmission (NGT) and their Project Union Scheme. To this end, the focus for the first three to four months following a positive funding decision, will be completing asset data gathering for the Project Union Enabling works, further defining the NGN Core Network, and establishing the Design Basis with the FEED Consultants whilst NGT finalise their options. The relationship between the NGT Project Union Works and the NGN Core Network is complex. This will require continual liaising between the Parties. The programme within Appendix 24 shows the dependencies between the activities both NGT and NGN need to undertake. NGN have made allowances for verifying initial FEED works following the completion of the NGT FEED for the Cowpen Bewley to Asselbey section of Project Union.

It is intended that the FEED study for Project Union Enabling will begin in early 2025 and be completed by Q2 2026, including final verification against the NGT Project Union FEED.

The FEED for both the NGN core network (HP/IP) and the NGN MP network will also begin in early 2025 with completion expected by mid-2026. It is intended to undertake a full review before the completion of the Design Basis of all the current potential demand options with a view to focusing on those options that provide a greater Cost Benefit. The options not selected in this initial review will be further assessed along with the Cumbria & Newcastle Areas in the Phase 5 Wider Development stage. This process may require the programme to be updated to reflect the revised priorities. The FEED delivery programme will focus on delivering each FEED based on when the demand is required i.e., the initial effort will be on delivering the Project Union Enabling FEEDs along with the high-priority pipelines/AGIs needing to be operational by 2028. Emphasis will then be placed on the remaining 2028 Projects followed by those targeting Operational delivery by 2032 and 2037. The "high priority" 2028 options will be defined as those that are critical to the wider rollout and provide the greater cost benefit.

The Phase 5 Pre-FEED for the wider NGN network will commence in late Q3 2025 once a greater understanding of the core network and the MP network has been achieved. It will also be dependent on the confirmation of the Project Union Cumbria/Scotland Transmission scheme.

NGN has made a provisional allowance for the works required following the production of the FEED packages. Once the Transport and Storage Business Model is further defined in January 2025, NGN will re-visit these allowances and re-submit further defined proposals for Ofgem to consider. These proposals will be to define the Environmental Assessments and Planning Processes (DCO/TCP/etc.).

The Project Management mentioned as a package above and the Environmental / Planning Consultation Packages will span the proposed FEED plan period.

The following plan outlines the planned FEED programme. The detailed programmes are contained within Appendix A24. NGN has included the following pdf views:

Complete programme showing all activities:

- Rolled up view showing the proposed Clusters but excluding the individual End Users
- Rolled up view showing the Project and Phases Key Milestones
- The following figure shows the ECH_2 FEED plan on a page.

A fully logic linked Primavera P6 file upon request.

Also included in Appendix A24 is a view of the typical individual FEED programmes for a repurposed pipeline, repurposed AGI, new pipeline and new AGI. These are indicative and will vary based on the length, size, complexity and location of each pipeline and AGI.

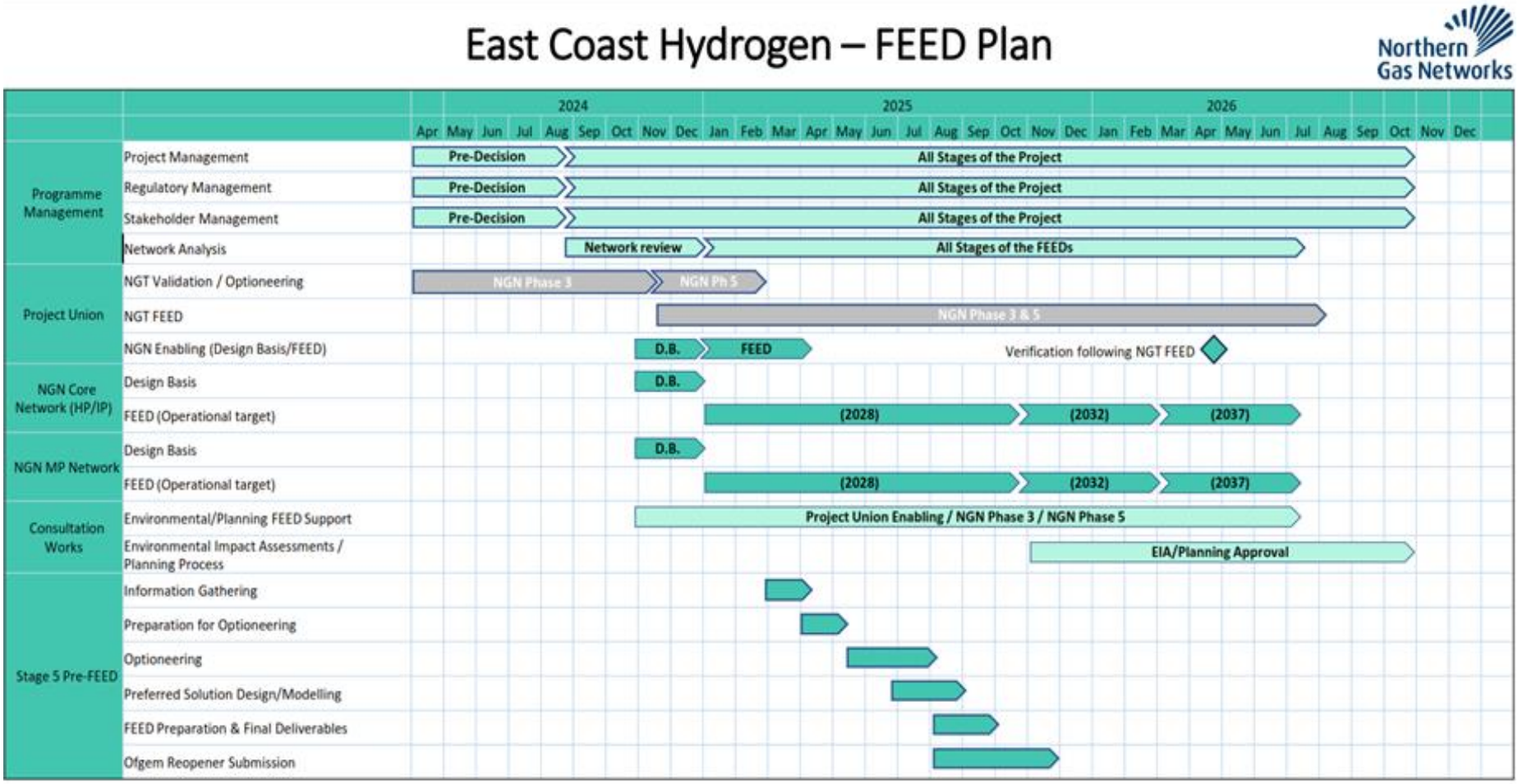

Figure 13. FEED Plan on a Page

8.4.1 FEED Stakeholder Engagement Plan

For the FEED, stakeholders have been divided into Direct & Indirect and engagement plans developed according to the type of engagement that will be required:

- *Direct Stakeholders* – These are the stakeholders required for the hydrogen network's development. This includes future users of hydrogen, hydrogen producers and hydrogen storage providers.
- *Indirect stakeholders* – These stakeholders will act as key enablers of the project. They include local authorities, various government bodies, and the wider industry.

All liaison and communication with stakeholders will be consistent, engaging, and meaningful. Through the stakeholder plan, stakeholders will:

1. Understand the project's purpose and how it will benefit the UK and them.
2. Be aware of project timelines and input needed at each point.
3. Have access to information in suitable formats.
4. Recognise the project team and have confidence in their engagements with them.
5. Have clarity on how any data they provide will be treated and with whom it will / will not be shared.

All stakeholder engagement activity and communications will be recorded using a central database (Tractivity) and various trackers to measure engagement, collate data, and avoid duplication.

8.4.1.1 Engagement Plan with Direct Stakeholders

Direct stakeholders have been identified as those whose engagement and commitment to the different spurs of the network will be crucial to achieving FID. These include:

1. *Hydrogen Users* – These will be the industrial and large commercial entities that will be connected to the network and use the hydrogen to decarbonise their processes.
2. Hydrogen Producers – These are the companies that produce hydrogen at scale, whether on green or blue plants, that will supply the network with hydrogen.
3. *Storage Providers* – These parties will provide long-term storage to the network by connecting either to their offshore or onshore storage solutions.
4. *Hydrogen Transmission Network* - As the first phase of ECH2, the relationship with NG will be critical in ensuring the development of the network.

Engagement with Hydrogen Users

Depending on the users' location in relation to the network or the clusters, the level of engagement required for each user will vary. Whether they are on a repurposed line, or a new line will also impact this level. The aim of the FEED will be to reach a level of commitment from the user to connect to the network. In most cases this will take the form of a Memorandum of Understanding (MOU). For each line of the network, a specific needs case will be carried out, determining the number of off takers required for that line.

Generally, the below process will be followed with all users:

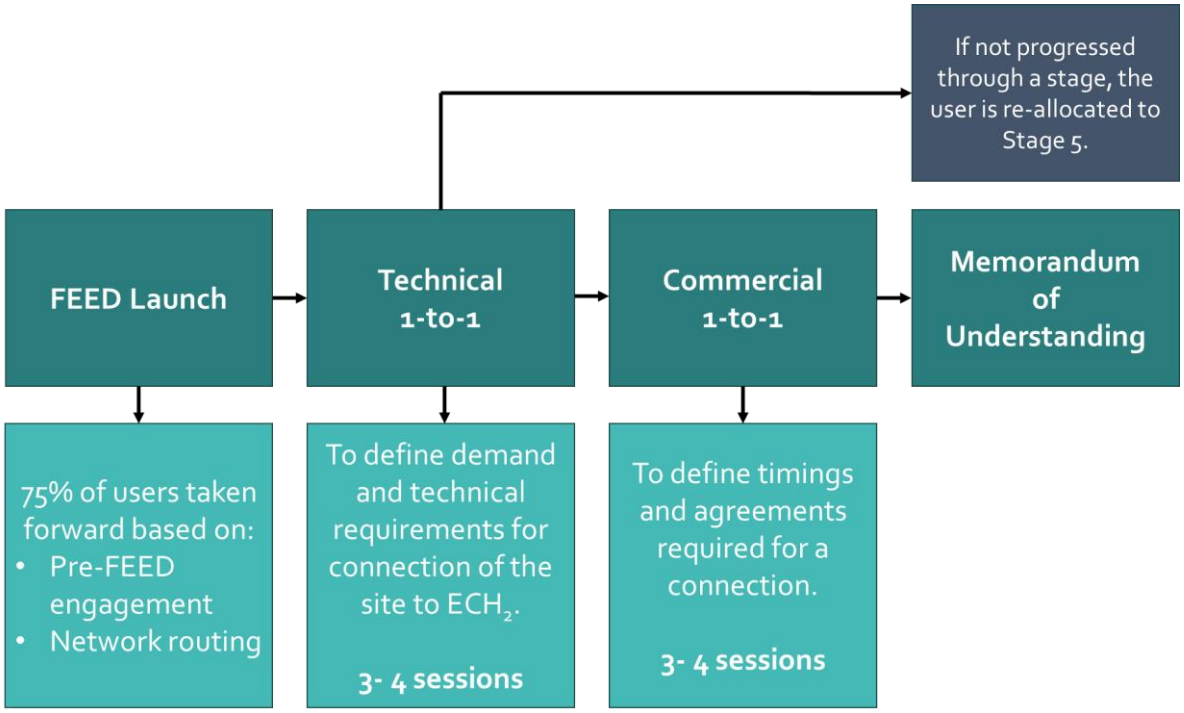

Figure 14. Flowchart through the stakeholder engagement process for the FEED.

After the completion of each of these steps, a needs case will be carried out to determine whether to proceed to the next stage and continue the engagement. Each user of gas that is not taken forward as part of Phase 3, will be considered as part of Phase 5.

A specific plan has been drawn for the following categories to consider the need for different levels of engagement:

1. **Stage 3**

a. *Users in clusters* – Due to their proximity to hydrogen producers, a level of understanding of the changes required to fuel switch to hydrogen will be expected. The engagement will focus more on demand required and alignment on routing with producers.
b. *Users in repurposed lines* – the certainty to offtake from users at the end of the line will need to be higher than those in between, as this will determine the length of a specific line.
c. *Users in new lines* – Similar to above, but the level of commitment may need to be higher due to the higher level of investment required.

2. **Stage 5**

a. *Users in Cumbria* – As the line to reach the users in Cumbria is a repurposed one, the level of engagement will be similar to the one in the Pre-FEED stage, where a Letter of Support and Data Capture Form was completed.
b. *Users in North Tyneside* – Due to the complexity of the network in North Tyneside, a level similar to that of Stage 3 for a new line would be required.
c. Additional spurs throughout the network that weren't delivered in Stage 3 or where new users arise.

Based on the above, at the beginning of FEED, each of the lines will be prioritised in terms of Needs Case and level of commitment to determine which users are targeted first.

As part of this package, the focus will also be given to developing uses of hydrogen and engagement with these projects will be sought. This will include but is not limited to:

- Sustainable Aviation Fuel
- Transport Hubs
- Heat Networks

Engagement with Hydrogen Producers and Storage Providers

Following the same pattern as engagement with hydrogen users, the focus with producers and storage providers will be to obtain MOUs to assure their commitment to supplying the network with hydrogen and providing large scale storage.

Similar to the above, a needs case will be carried out for each pipeline, and this will determine the amount of supply and storage needed for that route to be viable. To achieve this, the same process will be followed as shown in Figure 14.

Due to the creation of the NESO and the further development of the Transport and Storage Business Model will impact what the requirements will be for a hydrogen network, especially in terms of strategy and locations, it will be critical that the plan remains flexible and aligns with these developments throughout the FEED study.

Resource will also be allocated to align with the projects that progress through the HAR and Track mechanisms, as well as projects that produce hydrogen at scale from different sources such as Nuclear Hydrogen.

8.4.1.2 Engagement Plan with Indirect Stakeholders

We place our stakeholders at the heart of everything we do, and our East Coast Hydrogen plans for engaging stakeholders will adopt our established objectives and guiding principles, ensuring the insights of stakeholders positively influence and drive our FEED study.

Figure 15.NGN's stakeholder objectives and principles.

During engagement to date and in future engagement planning, NGN have identified and categorised the following stakeholders:

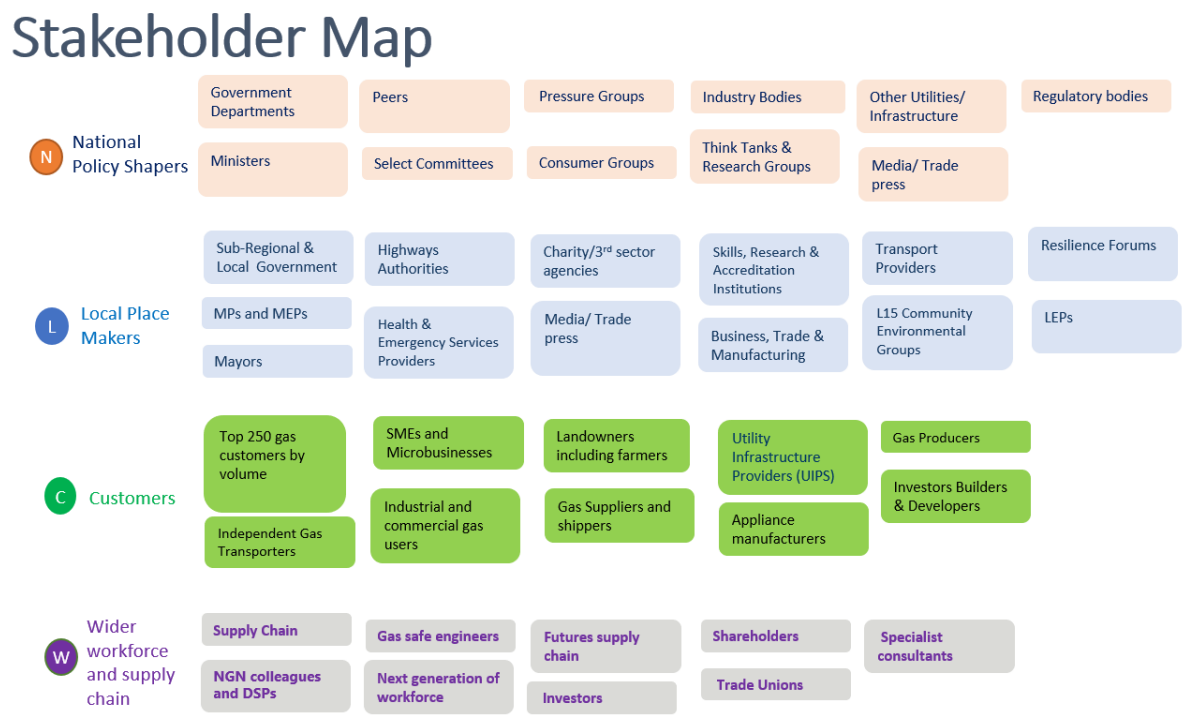

Figure 16. NGN's stakeholder map.

8.4.2 Project Delivery and Monitoring

The project will be executed in five distinct packages as described in Section 5.2. The project delivery team will be led by dedicated resource within the NGN's ECH2 project team.

This team will be responsible for the overall delivery of the collective outcomes of the five packages and will provide oversight for the whole project.

A project reporting structure and key performance indicators will be developed to monitor performance and quality of the project management services against time, cost, and quality metrics.

The governance structure identified will be organised as shown below. Details of the goals to be monitored through this work package have been included in Table 5.

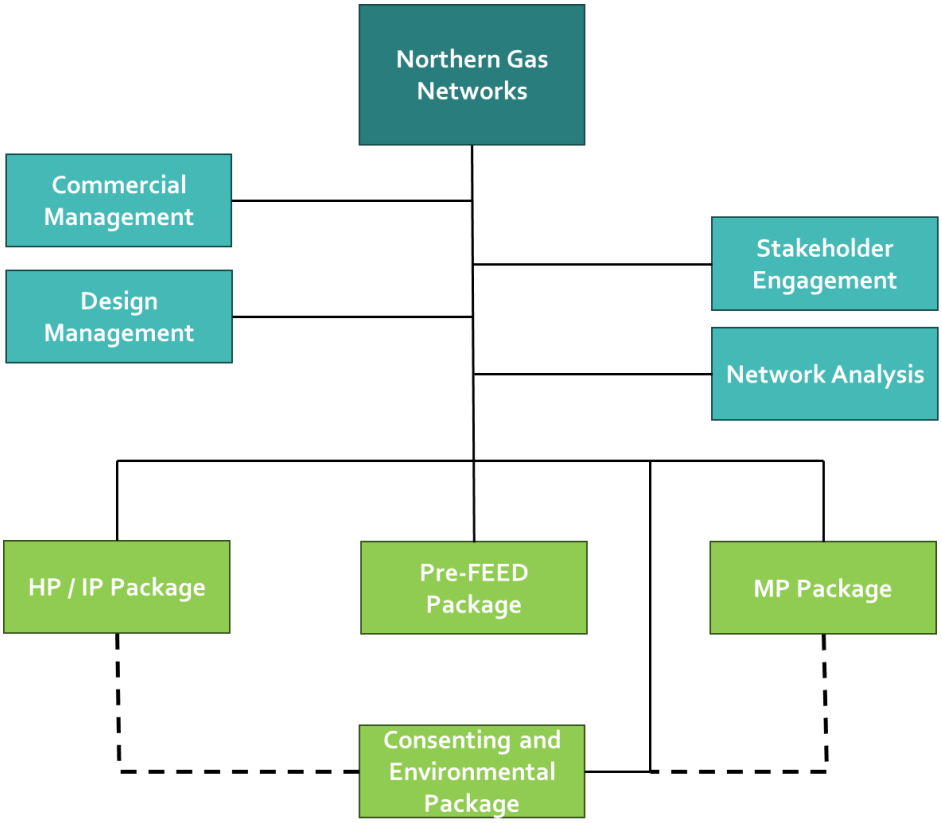

Figure 17. Project management governance structure.

The key critical milestones to be achieved from the FEED are summarised in the following table:

Table 5. Key milestones and delivery dates.

Work Package	Deliverable Goals	Delivery Date
Stake Holder Engagement	MOUs obtained for: • Users • Producers • Storage Providers For the identified core network as part of Phase 3.	March 2025
	Data Capture forms and letters of support obtained for users in Phase 5.	
Commercial Package	Cost of the project to deliver (CAPEX and OPEX) for each leg (re-purposed line, Re-purposing enabler and new line)	July 2026
	Identify requirement of commercial arrangements from all Off-takers, producers, and storage companies	
	Commercial risk identification and mitigation measures	
HP / IP Package	All drawings, Design Reports, Risk Assessment reports, Risk register	July 2026
	Long lead Item schedule	
	Material Take -Offs	
	Cost Report	
MP Package	All drawings, Design Reports, Risk Assessment reports, Risk register	July 2026
	Long lead Item schedule	
	Material Take -Offs	

Pre-FEED Package	Hydrogen Network map for Tyneside and Cumbria regions	November 2025
	Report for options	
	FEED cost	
	FEED Programme	

Throughout the FEED phase, the deliverable goals will be monitored against the delivery time and agreed cost with regular meetings and mitigation measures in place.

8.4.3 FEED Phase Project Governance

A project control manual will be developed at the beginning of the project and issued to package leads. The project control manual will be updated and re-issued from time to time throughout the life cycle of the project.

The objectives of the project control manual are to ensure the FEED phase of the project is delivered consistently in accordance with NGN requirements.

The key tasks and responsibilities covered in the project control manual will be:

- The delivery strategy is carried out in accordance with NGN policies and procedures.
- CDM (Construction and Design Management) responsibilities are defined.
- Management of Package contractors and sub-contractors – Technical, commercial and timelines (including competence / design management).
- Programme management.
- Appropriate meetings are carried out at predetermined frequencies.
- Risks are managed appropriately.
- Performance improvement (lessons learned).
- Consents, Approvals and Notifications are managed.
- Ofgem management and interface strategy management.
- Effective communication and reporting between internal and external stakeholders.
- Quality Assurance - during FEED (auditing/ monitoring/ handover records/ decisions traceability).

8.5 Key Business Risks and Opportunities

Specific Project risks have been set out in Appendix A25 – Project Risk Register submitted alongside this EJP.

8.6 Outputs included in RIIO GD2

This scope is additional to the requirements of RIIO 2. The mechanism for this type of work is the NZASP Re-opener.

This EJP is part of the submission for a NZASP Re-opener.