Alt Pipe Final Report

Exploring alternative uses for decommissioned pipelines

National Gas

Final version

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1. Executive Summary

1.1. Overview

Currently, redundant gas pipelines are maintained using nitrogen or grout filling, generating ongoing maintenance costs with no added value to consumers. Currently, there are 45 pipelines containing decommissioned segments, totalling 66 km of decommissioned assets. These pipelines are periodically monitored but have no alternate utility. This project sought to explore alternative uses, leveraging metrics such as pipeline repurposing rates and maintenance cost reductions to track progress. The aim was to support revenue streams for National Gas while supporting the whole system in its transition to Net Zero.

Project Alt Pipe identified decommissioned elements of redundant gas pipework on the transmission network which are unlikely to be used for refurbishment and explored the locational, technical and economic potential of repurposing for the following uses:

- Water
- Electric cables
- Heat
- Fuels
- Fibre optic cables
- Compressed Air Energy Storage (CAES)

Funded under Ofgem's Strategic Innovation Fund (SIF), the Alt Pipe project was commissioned by National Gas and jointly conducted by LCP Delta, Ramboll and EA Technology. This report provides an overview of the findings from the Discovery phase. The following Work Packages were developed and are summarised in Table 1 below. Included in the table are any deviations from the original proposal, all of which were carried out in full agreement with National Gas. Further detail on the deliverables can be found in the relevant sections of this report, as well as the accompanying PowerPoint documents.

Table 1: Work packages for Alt Pipe

Work Package	Deliverable(s)	Lead	Deviation from original plan?
Gas Transmission Network Assessment	**ArcGIS map** with layers depicting decommissioned assets and potential use cases for alternative technologies. A **report** summarising current and future gas transmission assets that are redundant or will become decommissioned and specifying the alternative use cases from alternative technologies.	LCP Delta	Out of 45 pipelines, only three contained decommissioned segments >2km long; the rest were excluded from analysis in agreement with National Gas.
Alternative Technology Network Assessment	A **report** that conducts technical analysis on the six proposed alternative technologies and assesses their viability for use in repurposed pipelines.	Ramboll, EA Technology	No
Business Model and Route to Market	A **report** that:	LCP Delta	CAES discounted from the cost benefit

	1. Develops various business model options for the various technology 2. Completes an impact assessment of the various technologies and business models 3. Details a cost benefit analysis for the various technologies. A **cost-benefit analysis** based on different technologies and scenarios.		analysis due to extremely poor suitability from the technoeconomic evaluation and impact assessment. This was a unanimous agreement among all partners, including National Gas.
Stakeholder Engagement	A **report** summarising the findings from stakeholder interviews that were conducted to align project goals with stakeholder needs and test the project's initial findings and assumptions.	LCP Delta	No

1.2. Initial findings

Initial findings clearly highlight that fibre optics is the most viable repurposing solution, offering high data capacity, minimal space requirements, and strong economic performance. District heating and aviation fuel also present promising use cases, especially in locations where pipelines intersect with potential heat offtakers or airport infrastructure. Electric cabling is a feasible application but will face severe technical and regulatory challenges. Meanwhile, CAES was ruled out due to its low energy density and poor technoeconomic feasibility.

Work Package 2 assessed the gas transmission network, identifying 3 decommissioned pipeline segments longer than 2km and analysing their attributes using ArcGIS. These were mapped alongside infrastructure datasets to evaluate reuse potential. The locational analysis revealed that two pipelines lie within 25 km of an airport, three heat networks are located within 10 km (all awaiting construction), and a cluster of four data centres was within 10km of one of the pipelines. Furthermore, the two pipelines that were in the vicinity of most of the infrastructure also lie in close proximity to the Humber industrial cluster, which is a hotspot of decarbonisation activity. These findings confirmed strong geographic overlap between the viable redundant assets and infrastructure demand, pointing to the viability of targeted, multi-utility repurposing.

Work Package 3 evaluated six alternative technology options for reuse: fibre optics, district heating, aviation fuel, electricity transmission, water, and compressed air energy storage (CAES). Fibre emerged as the most promising use case, with low retrofit costs (mechanical cleaning and inspection estimated at £18,000–£27,000/km), high data capacity, and minimal technical complexity. District heating was also found to be feasible, particularly using ambient systems, though installation costs were higher—around £1 million/km plus additional infrastructure such as energy centres and pumping stations. Aviation fuel pipelines presented a compelling economic case near airports, despite higher cleaning costs (~£120,000/km). CAES was ruled out due to low energy density and limited scalability, while electricity and water use cases face considerable technical and regulatory barriers.

A cost-benefit analysis in Work Package 4 used Future Energy Scenarios (FES) to model long-term asset value and supported the commercial case for reuse. Fibre optics showed strong net benefits over time, driven by stable leasing revenue and high demand for connectivity. Aviation fuel offered the highest returns in specific locations, offsetting significant initial investment with avoided costs of new pipeline construction. District heating performed well in areas with localised demand and favourable retrofit conditions. In contrast, water and electricity options were deprioritised due to cost, complexity, and regulatory uncertainty. Across all scenarios, repurposing just 10% of decommissioned assets delivered greater value than maintaining them in their current state.

The final work package focused on stakeholder engagement, including interviews with telecom providers, heat network developers, gas and electricity distribution networks, and pipeline representatives. This engagement validated the prioritisation of fibre, district heating, and aviation fuel, with stakeholders expressing strong interest in these applications. Participants highlighted regulatory clarity, access to infrastructure, and technical design as key next steps. Electricity and water reuses were met with lower enthusiasm, mainly due to operational and compliance challenges.

In summary, the Discovery Phase has shown that decommissioned gas pipelines can be successfully repurposed—particularly for fibre, district heating, and sustainable aviation fuel—offering a technically feasible and economically sound solution for legacy infrastructure.

This analysis will guide the selection of technologies and geographies to be progressed into the Alpha phase, where further multi-utility locational analysis, stakeholder engagement, and detailed design will take place to prepare for Beta trials.

1.3. Next steps

Following the successful completion of the Discovery Phase, the Alpha Phase of the Alt Pipe project will focus on refining technical options, identifying high-potential pilot sites, deepening the economic case, and engaging stakeholders to ensure the project is both feasible and aligned with industry needs. The goal is to build confidence in the proposed use cases and prepare a robust foundation for a Beta trial.

The objectives of the Alpha phase will be to:

- Validate and refine the prioritised technologies.
- Conduct detailed locational and infrastructure assessments to shortlist viable trial sites.
- Enhance the technoeconomic modelling and business case through granular, site-specific inputs.
- Establish early alignment with stakeholders, regulatory bodies, and delivery partners.
- Identify and mitigate any remaining technical, regulatory, or operational risks.
- Develop the design and implementation strategy for the Beta phase.

The Alpha phase will require the involvement of additional project partners to ensure the development of practical, scalable solutions. We anticipate engaging a Distribution Network Operator (DNO) or Gas Distribution Network (GDN), a consumer representative such as an airport operator, telecoms provider, or data centre, and a construction or engineering consultancy with experience in infrastructure repurposing. These partners will play a key role in validating use cases, informing technical design, and supporting the development of commercially viable delivery models.

The Alpha phase will build directly on the Discovery findings by deepening the technical, locational, regulatory, and commercial analysis of shortlisted technologies. The locations found in the Discovery phase may be validated through site visits and consultation with local authorities. In parallel, technical design scoping will begin—covering cleaning and lining requirements, performance specifications1 (e.g. pressure, flow, thermal conditions), and integration with third-party infrastructure. Preliminary engineering assessments, such as mechanical integrity checks and thermal modelling, will identify any constraints that may require further validation during the Beta phase.

Alongside the technical work, the team will map relevant regulatory pathways for each technology, engage early with key regulators, and explore viable asset transfer models, permitting routes, and funding mechanisms. The cost-benefit analysis will be expanded with site-specific retrofit costs, updated demand forecasts, and scenario modelling to reflect different ownership and delivery models. Broader impacts such as avoided emissions and local economic value will also be quantified. Stakeholder engagement will intensify, with targeted workshops involving local authorities, utilities, offtakers, and regulators to confirm demand, test commercial appetite, and identify early barriers.

By the end of Alpha, the project will aim to deliver updated CBA modelling, detailed technical briefs, a stakeholder engagement report, and a fully scoped Beta Phase Delivery Plan.

2. Gas Transmission Network Assessment

The following section outlines the mapping approach, data sources, and key locational insights used to inform infrastructure planning and technology prioritisation for the Alpha and Beta phases of the project.

National Gas provided a register of 45 gas transmission pipelines containing decommissioned segments, including details on their approximate location, diameter, decommissioning method, length, pressure, and wall thickness. Out of these 45, three pipelines contained decommissioned segments greater than 2km in length. The rest were excluded from analysis in agreement with National Gas.

Using this dataset, LCP Delta developed a comprehensive map in ArcGIS incorporating the following layers:

- **Redundant Gas Transmission Segments**. Supplied by National Gas, this layer identifies the location and attributes of the three decommissioned gas pipeline segments longer than 2km across the UK:
  - Easington to Paull 01F (23.35km)
  - Skitter to Thornton Curtis Fenceline (8.66km)
  - Dowlais to Dyffryn Clydach (2.65km)
- **UK Renewable Energy Pipeline**. Based on data from the Department for Energy Security and Net Zero (DESNZ), this layer was filtered to highlight:
  - Onshore wind and solar projects awaiting/under construction, therefore potentially awaiting grid connection, representing potential opportunities for electricity cabling.
  - Biomass, anaerobic digestion, and energy-from-waste projects that are operational or awaiting/under construction, which may serve as potential heat sources for heat networks.
- **Airports**. Data from the Civil Aviation Authority (CAA), identifying airports as potential offtakers for sustainable aviation fuel.
- **Heat Networks**. Data from DESNZ on both planned and operational heat networks, considered potential offtakers for distributed heat.
- **Operational Data Centres**. Using information from DataCenterMap, this layer identifies operational data centres that may require fibre connectivity, water, or electric cabling, and that could potentially serve as heat sources for heat networks.

A proposed layer depicting wastewater treatment plants was excluded due to difficulty in obtaining location data.

2.1. Locational Analysis Findings

A locational analysis was conducted using ArcGIS to evaluate the proximity of decommissioned gas transmission pipeline segments to relevant infrastructure and potential offtakers.

Two pipelines are located within 25 kilometres of an airport, outlined in Table 2 below.

Table 2: Airports within 25km of a decommissioned pipeline

Airport	Distance from segment (km)	Pipeline name
Humberside	17.71 7.47	[redacted]

Two pipelines lie within 10 kilometres of an active or planned heat network, outlined in Table 3 below.

Table 3: Heat networks under construction within 10km of a pipeline

Heat Network	Development status	Distance from segment (km)	Installed capacity (MW)	Pipeline name
Ferensway & Prospect Street	Awaiting construction	9.64 7.91	-	[redacted]
Kiln Lane Industrial Estate, Stallingborough - EFW Plant	Awaiting construction	8.04	20	[redacted]
Yorkshire Energy Park Phase 1 - Energy Centre and Data Centre	Awaiting construction	3.86 7.61	13.5	[redacted]

Four operational data centres were identified within 10 kilometres of a pipeline. These centres may represent future demand for fibre connectivity or electric cabling, as well as potential integration with local heat networks. They are outlined in Table 4 below.

Table 4: Data Centres within 10km of a pipeline

Data Centre	Distance from segment (km)	Pipeline name
Humber Tech Park Building 1	1.73	[redacted]
Humber Tech Park Building 2		
Humber Tech Park Building 3		
Humber Tech Park Building 4		

Seven potential renewable projects were found within 10km of a pipeline that could serve as a heat source for a heat network (anaerobic digestion, biomass, or EfW). Three of these are currently operational, with the other four awaiting construction. Seven solar projects were found, representing a total capacity of 50MW, with one under construction and the rest awaiting construction, having had planning permission granted. These could present potential sites that require electric cabling for a private wire connection in the face of a potentially years-long wait for a grid connection. These are outlined in Table 5, below.

Table 5: RES within 10km of a pipeline

Site Name	Technology	Development status	Installed capacity (MW)	Pipeline name
Bryn Pica AD / Tomorrow's Valley (Waste AD)	Anaerobic Digestion	Operational	1	[redacted]
Energy Works Hull - AD	Anaerobic Digestion	Operational	3	[redacted]
Singleton Birch, Melton Ross - Anaerobic Digestion Facility	Anaerobic Digestion	Awaiting Construction	N/A	[redacted]
King George Dock	Biomass (dedicated)	Operational	9	[redacted]
Kiln Lane Industrial Estate, Stallingborough - EFW Plant	EfW Incineration	Awaiting Construction	20	[redacted]
North Beck Energy Centre	EfW Incineration	Awaiting Construction	49.5	[redacted]
South Humber Bank Power Station	EfW Incineration	Awaiting Construction	95	[redacted]
Rhigos Road - Solar Farm	Solar Photovoltaics	Awaiting Construction	9.88	[redacted]
Hull Solar Farm	Solar Photovoltaics	Under Construction	25.7	[redacted]
Little Llwyn Onn - Solar Farm & Battery Storage	Solar Photovoltaics	Awaiting Construction	9.9	[redacted]
Bowmar Carr Road, Burton Pidsea	Solar Photovoltaics	Awaiting Construction	1	[redacted]

Cranswick Country Foods	Solar Photovoltaics	Awaiting Construction	1.5	[redacted]
Shed 27, Alexandra Road, South Immingham	Solar Photovoltaics	Awaiting Construction	1.07	[redacted]
Shed 10, Alexandra Road South, Immingham Docks	Solar Photovoltaics	Awaiting Construction	1.37	[redacted]

2.2. Next Steps and Alpha Phase

This analysis will inform the prioritisation of assets and technologies to be explored during the Alpha phase of the project. It will also support the selection of candidate locations for a targeted Beta trial.

Further multi-utility locational analysis will be conducted during the Alpha phase to identify integrated infrastructure opportunities. For instance, certain data centres may simultaneously receive fibre, water, or electric connectivity while serving as a heat source for adjacent heat networks.

It may also be prudent to assess the nearby Humber industrial cluster in more detail, particularly regarding any planned SAF projects that may need a piped connection to Humberside airport.

3. Alternative Technology Assessment

This section reviews technology options for pipeline repurposing, focussing on technical practicality, cost, and regulatory constraints.

National Gas Transmission (NGT) operates Britain's National Transmission System (NTS) for gas, which transports gas from entry points to power stations, industrial plants, storage facilities, local Gas Distribution Networks, and overseas via interconnectors. The NTS comprises nearly 8,000 km of pipeline, over 60 compressors at 21 stations, and more than 500 above-ground installations.

NGT are aware of the risks to their assets from decarbonization and are exploring commercial options for stranded assets or reserved ground. They are committed to identifying viable solutions to secure the future of their infrastructure.

Ramboll has been contracted by NGT to complete Work Pack 3 (WP3) to determine the technical viability of each technology assessed and develop high-level cost benchmarks for those technologies proven to be technically viable. This report will outline the key findings from the technology assessment and cost benchmarks and should be read in conjunction with the WP3 PowerPoint report.

The WP3 technology assessment will begin with high-level technical research on different technologies, followed by a viability assessment of implementation, capacity, and cost. The results will feed into SWOT analysis and an assessment matrix to rank and compare technologies, thereby identifying the preferred option for gas pipeline repurposing. The outcome of this work package will inform subsequent work packages, which will develop cost-benefit analyses for each technology assessed and help determine the preferred technology for existing gas pipeline repurposing.

Furthermore, EA Technology were contracted to present the technical and regulatory considerations of repurposing these pipelines for electrical cable distribution and transmission. This work follows on from the SWOT analysis undertaken by Ramboll and presents qualitative analysis that should be considered for this technology. Finally, we present one niche case that may be a viable use case.

3.1. Existing Gas pipeline

This section of the report provides an overview of the technical properties of the existing gas pipeline and the cleaning process required for the pipelines to be ready for alternative technology implementation.

A Request for Information (RFI) was sent to the client at the start of the project to obtain relevant data on the existing NTS pipeline, including pipe size, material, and length. The key characteristic of the existing gas pipeline is shown in Table 6.

Table 6: Existing NTS gas pipeline properties

Pipe sizes (DN)	Pipe material	Minimum wall thickness, mm	Maximum wall thickness, mm
450	Steel X52	9.5	11.9
500	Steel X46	11.1	11.1
600	Steel X60	9.5	17.5
750	Steel X52	11.9	12.7
900	Steel X60	11.9	15.9
1050	Steel X60	14.3	14.3

3.1.1. Gas Pipework Characteristic

From the client data, the NTS gas pipelines operate at high pressures of around 70–85 bar. These pipelines are made of high-strength carbon steel ranged from X52-60, designed to handle high pressure and tough environmental conditions.

A key challenge in managing gas pipelines is hydrogen sulphide (H_2S), a toxic and highly corrosive gas. H_2S can cause Sulphide Stress Cracking (SSC) and speed up pipeline corrosion, weakening the structure and increasing risks. To prevent this, chemical treatments and protective coatings are used to keep pipelines safe and long-lasting. Before repurposing pipelines for other uses, such as water transport, aviation fuel, or hydrogen, they must be thoroughly cleaned. Any gas residues, contaminants, or corrosion must be removed to ensure they are safe for designed purpose.

Based on the UK standards, gas pipelines are designed to last 40–60 years. However, they can operate longer with regular maintenance and inspections.

3.1.2. Pipeline Cleaning and Retrofit Requirement

After discussion with potential pipeline cleaning service provider (Adler & Allan and Pipetech Operations Limited) and Ramboll pipeline teams, detailed gas pipework cleaning and retrofit (lining) requirements prior to repurposing for all technologies considered are outlined below:

- Mechanical pigging (Physical residue removal).
- Chemical cleaning (Chemical residue removal, relevant to specific technology only).
- Flushing and Purging (as part of pigging/chemical cleaning to remove any leftover debris/chemicals).
- Epoxy/cement lining to provide flow enhancement and eliminate risks of contamination / corrosion from fluid coming into direct contact with pipeline. (only relevant to specific technology assessed).

Thorough cleaning is an important process if the repurposed gas pipeline is directly in contact with the delivered goods (e.g. water & aviation fuel) regardless of the lining application. This is due to Regulation 31 of the UK Drinking Water Inspectorate (DWI), any materials or coatings in contact with potable water must meet specific health and safety standards. Epoxy coatings must be approved for potable water use and must not leach harmful chemicals into the water. This is likely true for aviation fuel as well due to the high fuel standards requirement for aviation products.

A thorough cleaning of the pipework will ensue no harmful containments are leaked into the pipes/delivered goods in the event of lining failure/degradation.

3.2. Technical Assessment Summary

This section will outline the key findings and summaries of the technical assessment for each technology.

3.2.1. District Heating Network

A district heating network is a system that distributes heat from a central source to multiple buildings within a designated area. The heat is delivered to each building through a network of pipes, providing space heating and domestic hot water directly to homes and businesses. This centralised approach can help reduce carbon emissions and improve energy efficiency compared to individual heating systems. Since their inception in the late 19th century, district heating systems have evolved through several generations, each marked by improvements in technology, energy efficiency, and sustainability. The first-generation systems, which operated using steam as the heat carrier, were introduced in the 1880s and used until the 1930s. The second generation, which emerged in the 1930s, transitioned to pressurized hot water systems operating at temperatures above 100°C. In the 1970s, the third-generation systems introduced low-temperature hot water (LTHW) systems that prioritized energy efficiency and emission reductions, laying the foundation for many current networks. The different generation of network are shown in Table 7.

The fourth generation of district heating focuses on further integrating renewable energy sources, enhancing energy efficiency, and reducing carbon emissions. These systems operate at a low-temperature flow range of 50°C-80°C and are designed to work with modern, energy-efficient technologies. The fifth generation of district heating and cooling, relies on an ambient network to supply both heating and cooling demands by utilising an ambient temperature network (around 15°C – 25°C). Such a system relies on decentralised booster heat pumps local to the network customers to upscale the temperature to the specific heating or cooling requirements. It can reduce heat loss and enable the integration of diverse low-temperature heat sources. This further development of district heating networks can support the transition to sustainable, low-carbon energy systems for areas with heating and cooling demands or low waste heat opportunities. However, this ambient system's economic feasibility is yet unclear and depends heavily on heating and cooling demand co-occurrence. (Henrik Lund, 2021)

This report primarily examines fourth-generation Low-Temperature Hot Water (LTHW) systems and Ambient network systems, with a comparative analysis of steam systems also included.

Table 7: System parameters for different district heating system

System type	Temperature, °C	Description
Steam Based District Heating	>100	Steam based high temperature system.
High Temperature Water District Heating	80-100	Higher temperature 4th generation heat networks.
Low Temperature District Heating (LTDH)	50-80	4th generation heat network, Morden standards. Compatible with heat pumps.
Ultra-Low Temperature District Heating (ULTDH)	20 - 40	For future standard homes
Ambient network for heating and cooling	15-25	Provide heat source to network, heat generation at customer location

3.2.1.1 Material compatibility and cleaning requirements

The conversion of existing gas pipelines into District Heating Networks necessitates a series of structural and operational modifications to ensure system reliability and thermal efficiency.

First, a detailed structural integrity assessment is necessary to assess the pipelines' mechanical strength and thermal compatibility for transporting hot water or steam. This includes non-destructive testing methods, such as ultrasonic thickness measurements and hydrostatic pressure testing, to identify any potential structural weaknesses. Additionally, internal pipeline cleaning requires a meticulous process, starting with the complete removal of the existing gas pipeline coating. This is followed by surface preparation and cleaning to remove any gas residue. Finally, a new anti-corrosion coating, specifically designed for handling water and steam, must be applied.

Next, improving thermal insulation is essential for minimising heat loss during transmission. Alternatively, pre-insulated pipe systems can be used to enhance energy efficiency and extend the pipeline's lifespan. Finally, integrating repurposed pipelines with centralised heat sources requires further infrastructure modifications. These modifications include the installation of plate heat exchangers for indirect heat transfer, circulation pumps to maintain flow rates and pressure differentials, and automated control systems to manage temperature, demand, and pressure fluctuations. Proper hydraulic balancing ensures even heat distribution and operational stability. (Logstor, n.d.)

3.2.1.2 Pipe Sizing Calculations

The maximum sizes of the inner pipes in a pipe-in-pipe district heating system depend on the carrier pipe's internal diameter, ensuring space for two inner pipes, a 40mm annular gap, and sufficient clearance between pipes. Sizing also considers pipe wall thickness, standard dimensions, and allowances for installation feasibility and thermal expansion. Maximum inner pipe sizes are calculated considering a minimum annular gap of 40mm between pipes.

Table 8: Maximum Inner Pipe Sizes for Each Carrier Pipe

Diameter	Max Inner Pipe	Flow Area per Pipe (m^2)
DN450	DN150	0.02
DN500	DN200	0.03
DN600	DN200	0.03
DN750	DN250	0.05
DN900	DN300	0.07
DN1050	DN350	0.09

3.2.1.3 Heat Transfer and Heat Loss Analysis

Heat Transfer capacity (Q) can be calculated using:

$$Q = \dot{m}\, c_p\, \Delta T$$

$$\dot{m} = \rho\, \dot{V}\, A$$

where, the mass flow rate ($\dot{m}$) is found from the density (ρ), volume flowrate ($\dot{V}$) and cross-sectional area (A). The temperature difference across the hot and cold line (ΔT) and specific heat capacity of the medium (c_p) are also needed. For the heat transfer analysis, the basic heat loss equation, $Q_l = \frac{\Delta T_g}{R_{total}}$ is considered, where ΔT_g (K or °C) is the temperature difference between the ground and supply and R_{total} is the total thermal resistance (m.K/W). (Design Guide: Heat networks, 2021).

The potential heat distribution capacity per pipe sizes for both LTHW and Ambient network option are shown in Table 9 and Table 10.

Table 9: LTHW System Analysis

Diameter	Inner Pipe	Mass Flow, kg/s	Heat Capacity, MW	Heat Loss, W/m
DN450	DN150	41.3	5.2	15.1
DN500	DN200	75.2	9.4	19.3
DN600	DN200	75.2	9.4	19.3
DN750	DN250	118.5	14.8	23.6
DN900	DN300	169.8	21.3	27.9
DN1050	DN350	230.7	28.9	32.2

Table 10: Ambient network analysis

Diameter	Inner Pipe	Mass Flow, kg/s	Heat Capacity, MW	Heat Loss, W/m
DN450	DN150	42.1	1.8	5.8
DN500	DN200	76.7	3.2	7.5
DN600	DN200	76.7	3.2	7.5
DN750	DN250	120.8	5.1	9.1
DN900	DN300	173.1	7.2	10.7
DN1050	DN350	235.2	9.8	12.4

The ambient network requires larger pipe sizes to deliver the same heating capacity as LTHW, due to the lower temperature difference between (dT) the flow and return temperatures. However, the lower dT and reduced network temperature allow the ambient network to achieve significantly lower heat losses, approximately 30% less than LTHW systems

Ambient networks experience much lower heat losses compared to LTHW, with losses being roughly 30% of those in LTHW systems. Although ambient systems need larger pipe sizes to deliver the same heating capacity, they result in significantly reduced heat losses.

3.2.1.4 Cost Benchmark Summary

A cost benchmark has been developed based on previous project experience and high-level quotes obtained from the supplier. This is shown in Table 11.

Table 11: Cost benchmarks - District Heating

	Item	Value
Pipeline CAPEX	Mechanical cleaning & line inspection, £/km	£18,000-£27,000
	Pipe material/Installation, £/km	£1,000,000
	Spacer for pipe support, £/km	£50,000
Additional CAPEX	Energy Centre, £/kW	£2,000 - £4,000
	Pumping station, £/kW	£5,000
OPEX	Maintenance, £/kW/yr	£100-£200
	Pipe maintenance, £/km/yr	£8,000
	Cost of electricity (fuel), £/MWh	£162.1
	Cost of electricity (natural gas), £/MWh	£30.9

Conclusions

This is a feasible technology. A pipe-in-pipe system with ambient temperatures offers enhanced practicality and reliability for district heating networks. Despite the inherent capacity reduction associated with this system, its design facilitates more stable flow characteristics, including improved flow stability, reduced pressure drops, and controlled velocity, compared to coaxial systems.

For gas pipeline conversion to district heating, ambient systems offer superior long-term benefits compared to LTHW and Steam systems, despite lower heat transfer capacity, particularly in scenarios prioritising energy efficiency and future-proofing for renewable integration.

In a pipe-in-pipe ambient system installed within an existing gas pipeline, the insulation should be applied primarily to the individual flow and return pipes to improve thermal efficiency, condensation prevention (vapor barriers on return pipes), heat loss reduction, and space optimisation (aerogel or vacuum insulation panels).

The reduced operational temperatures in ambient systems significantly reduce maintenance requirements, provide operational flexibility, extend system lifespan, and have better compatibility with low-carbon heat sources.

The insertion of two distinct pipes within an existing main pipe presents significant engineering challenges, including amplified pressure drops, increased pumping energy requirements, and thermal short-circuiting that reduces system efficiency.

Structurally, differential thermal expansion, material fatigue at support points, and limited inspection access increases the risk of premature failure, undetected leaks, and accelerated corrosion, compromising long-term system reliability. While there are existing examples of converting gas pipelines for use in district heating systems, the proposed ambient system is still in the pilot phase and has yet to be implemented in any operational networks.

3.2.2. Aviation Fuel

3.2.2.1 Material compatibility and cleaning requirement

This is a feasible technology. Natural gas operates at a higher pressure than aviation fuel pipelines and requires a stronger pipe material selection (or higher wall thickness) than aviation fuel. This means that the existing natural gas pipeline is structurally capable of transporting aviation fuel, provided the integrity of the existing gas pipeline has not been compromised. Additionally, aviation fuel pipeline uses carbon steel as pipe material (Aviation Fuel Pipeline, n.d.), which is the same as natural gas pipeline.

Although it is important to note that the NTS pipeline must undergo a thorough cleaning process to ensure no gas or contaminant residues are left in the pipeline to prevent aviation fuel contamination, given that jet fuel quality is of the highest priority from a safety perspective.

The key challenges lie in identifying the right gas pipework routes to link fuel depots to airports/airfields.

3.2.2.2 Technology Capacity Summary

The potential quantity of fuel transported per pipe sizes is shown in Table 12.

Table 12: Aviation fuel transportation potential per pipe sizes

Pipe size	Transport Potential, m3/h	Transport Potential, tonnes/h
450	859	691
500	1,060	852
600	1,527	1,228
750	2,386	1,918
900	3,435	2,762
1050	4,676	3,759

3.2.2.3 Cost Benchmark Summary – Aviation Fuel

A cost benchmark has been developed based on previous project experience and high-level quotes obtained from supplier. This is shown in Table 13.

Table 13: Cost benchmark - Aviation fuel

	Item	Value
Pipeline CAPEX	Mechanical cleaning & line inspection, £/km	£18,000-£27,000
	Chemical cleaning, £/km	£120,000
Additional CAPEX	Pumping station, £/kW	£5,000
OPEX	Maintenance, £/km/yr	£2500-£3500

3.2.3. Compressed Air

There are a total of three different types of CAES systems/technologies that had been either commercially viable or experimentally tested. These CAES technologies are:

- Traditional CAES.
- Adiabatic CAES.
- Isothermal CAES.

Traditional CAES system are well developed concept, however it has the lowest efficiency amongst the 3 CAES technologies and involves the use of fossil fuel to preheat the compressed air prior to turbine heat generations (Heidar Jafarizadeh, M. Soltani, Jatin Nathwani, 2020). Adiabatic are more advanced system that can achieve a greater energy system efficiency than traditional CAES. However, aside from compressed air storage space requirements, adiabatic CAES also requires thermal storage system to achieve the high efficiency. On the contrary, Isothermal CAES are still largely a conceptional design while there is not existing large-scale plant to prove its technical viability.

3.2.3.1 Material compatibility and cleaning requirement

This is not a feasible technology. The pipeline itself is structurally strong enough to store the compressed air at 40 bars (as bare minimum pressure to generate energy). However, the system is less convincing on efficiency as CAES systems have a round-trip efficiency of 45%–70% (Elmegaard, Brian and Brix, Wiebke, 2011), with a pre heat requirement of 250°C and above (Isothermal system excepted, but the system itself is still a concept). Additionally, most CAESs requires a large volume of air storage space to be technically and economically viable, in the scales of > 100,000 m^3.

The overall available storage space is assessed based on pipe sizes and length available to use under the following chapters.

3.2.3.2 Technology Capacity Summary (Base case)

For this assessment, a pipe length of 10 km is assumed per pipe size, and the energy storage has a discharge period of 1 hour to calculate the total pipework capacity on a kWh basis for a sense of scale. The storage capacity per 10km of pipe per pipe sizes is shown in Table 14.

Table 14: CAES capacity per pipe sizes

Pipe size	Pipe volume (10 km), m^3	Isothermal, kWh (availability of energy in air stored, excl. losses)	Adiabatic, kWh (availability of energy in air stored, excl. losses)
450	1,590	163	206
500	1,963	201	255
600	2,827	290	367
750	4,418	453	573
900	6,362	652	826
1050	8,659	887	1124

As shown in Table 14 due to the nature of pipe sizes, repurposing existing NTS pipelines for CAES is technically unviable because of the low energy capacity potential (or low energy density) and the pipe length required to achieve a minimum useful/meaningful capacity.

It has been proven via calculation that, even with 10 km of pipework and a pipe size of DN1050, the storage potential is only 1124 kWh for an hour, excluding turbine efficiency. To put it in perspective, such a storage capacity can only store the total electricity generated by a 1 MW wind turbine for 1 hour during a period of excessive generation (a single 60 m tall wind turbine).

Since the technology has been deemed as unavailable from the technical perspective, a cost benchmark will not be developed.

3.2.3.2 Technology Capacity Summary (Alternative)

An alternate scenario is developed to assess the potential supply capacity of existing gas pipelines to transport compressed air from an underground storage cavern to a power plant.

The assessment assumes an existing underground salt storage cavern and an existing power plant located close to the cavern to minimize losses during compressed air transportation. Assuming a discharge velocity of 24.6 m/s (Hämmerle, M. et.al, 2017) with adiabatic power generation, the potential power generation per pipe sizes are shown in Table 15.

Table 15: CAES capacity per pipe sizes

Pipe size	Volumetric flow rate at discharge velocity of 24.6 m/s, m^3	Potential power generation, MW
450	3.9	49
500	4.8	60
600	7.0	87
750	10.9	135
900	15.7	195
1050	21.3	265

However, despite the high-power generation capacity that can be achieved using existing gas pipes for compressed air discharge/transportation between the storage cavern and the power plant, this is still not a viable technology for implementation. This is due to: 1) Underutilization of pipes, as an ideal CAES system should have the storage cavern located onsite and close to the power plant. Therefore, the required piping between the cavern and power plant should be within a few kilometres in range. 2) This requires a high geological coincidence, as it necessitates a power plant to be located next to an existing underground salt cavern or vice versa.

3.2.4. Potable Water/ Sewage

3.2.4.1 Material compatibility and cleaning requirement

This is a feasible technology. The cleaning process must ensure that any remaining gas residues and contamination (H_2S carbon steel pipeline impregnation) are fully eliminated within the pipes. Where there is a high level of contamination or if the existing gas pipe has been damaged, pipe lining (epoxy lining) can be applied internally to the affected sections of the pipes.

3.2.4.2 Relevant regulations

- Water Supply (Water Quality) Regulations 2016 (England & Wales).
- Regulation 31 of the Water Supply (Water Quality) Regulations.
- BS 6920: Suitability of Non-Metallic Products for Use in Contact with Water.
- BS EN 10289: Coated Steel Pipes for Water Pipelines.
- BS EN 10339: Coated Steel Water Pipes.

3.2.4.3 Technology Capacity Summary

The potential quantity of water/wastewater transported per pipe size is shown in Table 16. It is assumed that the potable water main would have a flow rate circa 1 m/s per the design guide (Bristol Water, 2023).

Table 16: Water transportation potential per pipe size

Pipe size	Cross sectional area, m^2	Water delivery capacity, m^3/h	Water delivery capacity, kg/h
450	0.16	573	572,424
500	0.20	707	706,696
600	0.28	1,018	1,017,642
750	0.44	1,590	1,590,065
900	0.64	2,290	2,289,694
1050	0.87	3,117	3,116,528

3.2.4.4 Cost Benchmark Summary - Water

A cost benchmark has been developed based on previous project experience and high-level quotes obtained from supplier. This is shown in Table 17.

Table 17: Cost benchmark - Water

	Item	Value
Pipeline CAPEX	Mechanical cleaning & line inspection, £/km	£18,000-27,000
	Chemical cleaning, £/km	£120,000
	Lining, £/km	£360,000 – 840,000
Additional CAPEX	Pumping station, £/kW	£5,000
OPEX	Maintenance, £/km/yr	£0.6-0.9
	Equipment and Energy, £/MW	£25-40

3.2.5. Fibre

3.2.5.1 Material compatibility and cleaning requirement

This is a feasible technology if the pipeline is appropriately clean with mechanical cleaning to remove any physical constraints that could potentially damage the fibre cable during installation stage. Additionally, fibre cables are often prefabricated with a plastic coating that is resistant to low levels of H_2S contamination. However, if during the line inspection stage, high levels of H_2S contamination is identified at particular sections of pipes, the appropriate fibre cable coating should be selected per manufacturer guidance to avoid any potential long-term corrosion.

3.2.5.2 Relevant regulations

- BS EN 50174: Information Technology - Cabling Installation.
- BS 6701: Telecommunications Equipment and Telecommunications Cabling - Specification for Installation, Operation, and Maintenance.
- BS EN 60794: Optical Fibre Cables.
- Telecommunications Industry Association (TIA) Standards: TIA-942 - Telecommunications Infrastructure Standard for Data Centres.

- British Telecommunications Engineering Safety Rules and Instructions.

3.2.5.3 Technology Capacity Summary

The potential data transportation capacity per pipe sizes are shown in Table 18. The data capacity of fibre cable was determined based on manufacturer/supplier data (CMW Ltd, n.d.).

Table 18: Available potential data transportation capacity per pipe size

Pipe size	Pipe volume (10 km), m^3	12 Core fibre cable (small), Tbps	24 Core fibre cable (city telecom scale), Tbps	144 Core fibre cable (large data centre), Tbps
450	1,590	312	384	720
500	1,963	360	456	864
600	2,827	540	672	1,152
750	4,418	900	1,152	2,016
900	6,362	1,260	1,608	2,880
1050	8,659	1,800	2,304	4,176

3.2.5.3 Cost Benchmark Summary - Fibre

A cost benchmark has been developed based on previous project experience and high-level quotes obtained from supplier. This is shown in Table 19 .

Table 19: Cost benchmark - Fibre

	Item	Value
Pipeline CAPEX	Mechanical cleaning & line inspection, £/km	£18,000-£27,000
Additional CAPEX	Fiber installation, £/km	TBC
OPEX	Maintenance, £/km/yr	TBC

3.3. SWOT analysis

A SWOT analysis was conducted for each technical option assessed to provide a comprehensive evaluation of each technology from a technical performance and cost perspective. This approach allows the key strengths, weaknesses, opportunities, and threats associated with each technology option to be identified. By identifying these key attributes, such as efficiency, reliability, potential benefits, and risks, each viability of each technology can be directly compared with each other.

The SWOT analysis will also feed into the 'Assessment Matrix,' along with the technical assessment outcomes, for scoring to determine the most and least viable technical options through ranking.

3.3.1. SWOT analysis output

The output of the SWOT analysis can be found in Table 20 and can also be found in the WP3 PowerPoint report.

Table 20: SWOT analysis

Strengths, Weaknesses, Opportunities and Threats Analysis					
	CASE	**District Heating**	**Fibre**	**Potable/Waste Water**	**Aviation Fuel**
Strength	• Decarbonisation potential from storing excessive green energy produced • Use of air as primary fuel source, which is abundant with no costs • Only one stakeholder (no issues with multiple stakeholders)	• Use a well proven technology that can save cost for trenching which will lead to high appetite for connection if heat load is available • Only one stakeholder (the ESCo) no issues with multiple stakeholders. • Low carbon technology available • If near a heat demand/waste heat source/industrial complex can act as a heat highway	• Significantly Lower carbon emission than gas delivered via pipe • Add resilience to local area with additional data capacity • Accelerates fibre network expansion by using pre-existing pipeline routes.	• Does not require additional complex system • Only one stakeholder (no issues with multiple stakeholders) • Low carbon • Pipelines already follow optimal paths, minimizing the need for new right-of-way approvals • Some gas pipeline control mechanisms can be adapted for water transport.	• Does not require additional complex system • Utilising existing infrastructure reduces capital costs compared to laying new pipelines. • Add resilience/future proof to airports fuel needs
Weakness	• Complex systems • large land space requirement from power and compressor station • High surface to volume ratio when using pipes as storage space. (low energy density per m of pipe) • Lower storage pressure due to pipe material limitation	• Limited capacity from fitting 2 pipes inside the pipe. • Requires reinforcement in regular intervals inside the pipe to hold it in place • District heating network needs to be near a heat demand	• Require large data consumption source • Aging or corroded pipelines may not be structurally sound for housing fibre cables. • Moisture buildup and temperature variations inside pipelines could impact fibre performance. • May be difficulties in retrieving, repairing, or upgrading fibre cables once installed due to pipe shells	• Require water consumption demand • Does not generate a lot of revenue • NTS gas pipeline material is less compatible with potable water pipeline	• Aviation fuel transport is subject to strict safety and quality regulations, which may complicate the repurposing process. • Geographically dependent on airport demands and fuel depot locations • Older pipelines may require extensive testing and reinforcement to prevent leaks. • Not a low carbon/carbon free technology

Strengths, Weaknesses, Opportunities and Threats Analysis					
	CASE	**District Heating**	**Fibre**	**Potable/Waste Water**	**Aviation Fuel**
Opportunities	• High revenue if pipes are next to large CCGT power plants and green energy sites • Potential to expand power plants capacities within the UK • More renewable energy generation sites to utilise storage	• Could facilitate development of heat networks in areas where trenching costs would deem it non doable	• Lower cleaning requirement required. Pipe retrofit likely not needed • Provide additional capacity for data centre development. • Helps bridge digital gaps in remote and underserved areas • Pipeline-protected fibre is less prone to damage from storms, wildfires, or accidents.	• Converting pipelines to potable water mains could increase land development potential in nearby undeveloped areas. • Maximizes the value of aging or underused gas pipeline networks.	• Low cost and high revenue as majority of pipeline are existing • Provides additional/expansion potential to existing airport • Potential increase in air travel and fuel supply chain needs may justify pipeline repurposing projects.
Threats	• Fossil fuel free technology is not well established • Limited no. of larger commercially viable plants exists • Most fossil fuel free plant are still at pilot stage • Tight gov regulations and permit acquisition. • Plant generation capacity limited by available pipe space	• Limited to areas with heat demand and existing routing of pipe.	• Existing NTS pipeline may already run next to existing fibre cables • May increase grid capacity requirement if additional data centre were to be built	• Existing NTS pipeline may already run next to existing potable water main • Potential contamination issues could pose serious health hazards • Stringent water safety regulations may delay or prevent approval • Water quality failures could result in costly legal disputes and reputation damage.	• Existing pipeline needs to be near both fuel depot and airport with demand requirements • Encourage airport expansion/new airport construction and therefore increase fossil fuel consumption • Stringent jet fuel safety regulations may delay or prevent approval • Jet fuel quality failures could result in costly legal disputes or even disasters

Figure 1: SWOT analysis output

3.4. Assessment Matrix

An assessment matrix is a tool designed to score the performance of various technologies based on the inputs from previously conducted SWOT analysis and technical and costing assessments. The matrix evaluates each technology to identify the most applicable and relevant solution based on factors such as cost, technical viability, efficiency, and performance. The scoring is done in descending order for each category assessed, where lower scores often represent good performance, high revenue potential, low complexity, etc., while higher scores indicate poor performance, high costs, and low revenue potential, etc.

Furthermore, the assessment matrix helps visualize the performance and rank of the technologies assessed, providing a clear and comparative overview of their strengths and weaknesses. This enables stakeholders to make informed decisions about which technology to implement for pipeline repurposing, ensuring the most cost-effective and efficient solution is selected.

3.4.1. Assessment matrix analysis output

The output of the assessment matrix can be found in Figure 2. From the Assessment Matrix, Fiber was identified as the preferred technology due to its excellent economic performance, characterized by high 'energy' density, and its ease of conversion. The high capacity with minimal spatial requirements makes fiber cable an optimal choice. Following in rank were aviation fuel and water systems, which also demonstrated good economic performance and feasibility, making them viable alternatives for gas pipeline repurposing.

Although district heating technologies achieved a lower ranking, their performance score was similar to that of aviation fuel and water applications. Therefore, district heating technologies should still be considered if the preferred options, such as fiber cable, are determined to be non-viable during the subsequent design stage. Their viability in terms of technical and economic aspects warrants further exploration under certain conditions.

On the other hand, compressed air energy storage (CAES) technology scored the poorest in the assessment. This was mainly due to its low storage capacity and energy density, coupled with the complexity involved in system integration and underlying risks. Given these significant challenges and costs, **CAES should not be considered a viable option** for repurposing existing gas pipelines. Based on the assessment matrix, the preferred technology identified is fiber installation while CAES scores the lowest due to cost and deliverability (lack of information on performance and existing technologies).

The key findings identified from Assessment Matrix is outlined in Section 3.5 - Summary.

SIF pipeline Assessment					
Weighting	40%	35%	25%		
Criteria	Economic viability	Energy Supply / Use	Planning & Deliverability	**Total Score**	**Ranking**
Technology solutions					
4th Generation District Heating	2.4	3.2	3.6	3.0	5
Ambient Thermal Network	3.3	3.2	3.8	3.4	6
Potable Water	2.8	2.0	3.9	2.8	2
Sewerage	3.1	2.0	3.9	2.9	4
Aviation Fuel	1.8	3.0	4.4	2.9	3
Fibre / Cabling	1.6	1.7	4.3	2.3	1
Compressed Air Storage	3.6	3.5	4.9	3.9	7

Figure 2: Assessment matrix output

Fiber cable was identified as the preferred technology due to its excellent economic performance, characterized by high 'energy' density, and its ease of conversion. The high capacity with minimal spatial requirements makes fiber cable an optimal choice. Following in rank were aviation fuel and water systems, which also demonstrated good economic performance and feasibility, making them viable alternatives for gas pipeline repurposing.

Although district heating technologies achieved a lower ranking, their performance score was similar to that of aviation fuel and water applications. Therefore, district heating technologies should still be considered if the preferred options, such as fiber cable, are deemed non-viable during the detailed design stage. Their viability in terms of technical and economic aspects warrants further exploration under certain conditions.

On the other hand, compressed air energy storage (CAES) technology scored the poorest in the assessment. This was mainly due to its low storage capacity and energy density, coupled with the complexity involved in system integration and underlying risks. Given these significant challenges and costs, CAES should not be considered a viable option for repurposing existing gas pipelines

3.5. Summary

Ramboll has been contracted by National Gas Transmission to conduct Work Package 3, which involves developing a high-level technical assessment to identify potential viable alternative technologies for repurposing redundant gas pipelines.

The technology assessment process involved a high-level evaluation of each technology’s technical viability, costs, and SWOT analysis. The output from these assessments was used to formulate the assessment matrix, where each alternative technology was compared and ranked to identify the list of technologies that should be prioritized or preferred for further assessment.

The assessment matrix identified fiber as the prioritised preferred technology for pipeline repurposing due to its excellent economic performance, high data transportation capacity, minimal spatial requirements, and overall ease of conversion. Subsequent technologies from the assessment matrix output, such as water and aviation fuel, should also be considered despite their lower ranking. However, they should only be evaluated if the preferred options with better performance are discounted during later design stages.

A high-level technical viability and costing assessment has been conducted to evaluate alternative solutions for repurposing existing gas pipelines. The technologies considered include district heating networks (LTHW and ambient network), aviation fuel transportation, compressed air energy storage (CAES), water (potable water and wastewater), and fiber cable. This assessment aimed to identify the most feasible and cost-effective technology for repurposing the pipelines.

Fiber cable was identified as the preferred technology due to its excellent economic performance, characterized by high 'energy' density, and its ease of conversion. The high capacity with minimal spatial requirements makes fiber cable an optimal choice. Following in rank were aviation fuel and water systems, which also demonstrated good economic performance and feasibility, making them viable alternatives for gas pipeline repurposing.

Although district heating technologies achieved a lower ranking, their performance score was similar to that of aviation fuel and water applications. Therefore, district heating technologies should still be considered if the preferred options, such as fiber cable, are deemed non-viable during the detailed design stage. Their viability in terms of technical and economic aspects warrants further exploration under certain conditions.

On the other hand, compressed air energy storage (CAES) technology scored the poorest in the assessment. This was mainly due to its low storage capacity and energy density, coupled with the complexity involved in system integration and underlying risks. Given these significant challenges and costs, CAES should not be considered a viable option for repurposing existing gas pipelines.

This evaluation ensures that the selected technology is not only cost-effective but also technically feasible, thereby optimising the repurposing of existing infrastructure for sustainable use.

3.5.1. Next Steps

The next steps should consider:

- A more detailed technical study shall be conducted for the shortlisted (higher-ranking) technologies, including:
- Identifying the demand and potential consumer locations.
- Assessing the technical viability in detail, including appropriate cleaning and lining plans (if required).
- Identifying the condition of the existing pipeline and indicating locations where contamination may exist.
- Providing a detailed pipeline network route drawing for the pipeline of interest.
- Early stakeholder engagement.
- Developing detailed designs for the preferred technology solution for procurement.
- Engaging the market early to identify key challenges and requirements for large-scale pipeline repurposing work.

3.6. References

3.6.1. District Heating

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3.7. Purpose and scope

EA Technology conducted a comprehensive assessment to identify the key benefits and potential opportunities associated with repurposing elements of the National Gas Transmission Network. This evaluation focused on its feasibility as an innovative conduit for the large-scale distribution and transmission of electricity, exploring both technical and economic implications to inform future energy infrastructure strategies. This summary should be read in conjunction with the more detailed WP3 report prepared by EA Technology for National Grid.

3.8. Key Findings

- 66kV and 132kV networks are best suited for pipeline repurposing due to their distance compatibility and minimal access needs.
- Internal diameter limits may restrict installations to a single cable; multiple sets require further analysis.
- Access points are needed for pulling and jointing, as block valves are too widely spaced.
- Pipeline durability must exceed the cable's lifespan; older pipes may reduce long-term viability.
- Alternating Current (AC) corrosion risks are not fully understood and need further study.
- No formal regulatory process exists; Ofgem, HSE, and National Gas must address asset ownership, safety, and compliance.
- ESQCR 2002 requirements must be met, including insulation, earthing, and fault detection.
- Long-distance use may trigger Environmental Impact Assessments.
- Repurposing may be viable only in specific use cases, such as High Voltage Direct Current (HVDC) from offshore wind.

3.9. Technical Feasibility Assessment summary

The feasibility of repurposing gas transmission pipelines for electricity infrastructure requires consideration of multiple engineering constraints, including thermal performance, mechanical suitability, electromagnetic interference, and long-term maintenance access. Benefits that would be derived from utilising existing gas network infrastructure for electricity networks can be summarised as:

- Use of existing infrastructure: Gas pipelines provide a pre-existing underground conduit, potentially reducing civil engineering and land acquisition costs.
- Mechanical Protection: Steel pipelines offer greater protection from third-party damage compared to direct-buried cables.
- Reduced Environmental and Planning Impact: Using existing pipeline corridors may limit the need for new construction and reduce environmental disruption.

Analysis identified significant technical challenges that make repurposing gas pipelines for electricity distribution unlikely to be viable in most cases. These include:

3.9.1. Thermal Limitations

High-voltage (HV) cables generate significant heat during operation, and housing them within a sealed steel pipeline creates substantial heat dissipation challenges. Unlike direct-buried cables, which can release heat into surrounding soil, cables in a pipeline are enclosed in air, resulting in thermal build-up. If this heat is not properly managed, conductor temperatures may exceed insulation limits, leading to degradation, accelerated ageing, and potential failure.

AC cables experience greater resistive losses than DC cables, further contributing to heat generation. To avoid overheating, forced cooling systems or reduced loading may be required, both of which can limit the capacity and efficiency of the system.

Extended exposure to high temperatures can also lead to thermal expansion in the conductors, increasing mechanical stress and reducing operational life. These issues become more critical when multiple circuits are installed within the same pipeline. For example, 132kV cables require a minimum spacing of 45 centimetres to prevent mutual heating, which restricts the number of circuits that can be safely installed.

3.9.2. Electromagnetic and Corrosion Risks

The steel enclosure around HV AC cables induces electromagnetic coupling, creating several operational challenges. Alternating magnetic fields generate eddy currents in the steel, leading to localised heating, increased energy losses, and potential cable overheating. These fields also accelerate AC corrosion, especially in low-resistivity soils, where induced voltages cause faster material degradation. Electromagnetic interference (EMI) from AC cables can disrupt nearby communication and control systems. The steel pipeline may conduct stray currents, affecting surrounding infrastructure. To address these risks, the system would require specialist earthing and bonding to manage induced currents, voltage fluctuations, and corrosion.

3.9.3. Cable Installation and Maintenance Challenges

Installing and pulling HV cables through long pipeline sections presents mechanical challenges due to pipeline geometry, bend restrictions, and pulling force limits. Gas pipelines, designed for fluid transport, include 3D bends, expansion loops, and welded joints. These features obstruct cable installation and require modification, unlike purpose-built electricity ducts. 132kV aluminium cables have a maximum pulling tension of around 2,752 kg, limiting installation lengths to roughly 1.1 km. Standard pulling methods may not be suitable, requiring hydraulic pushing or segmented installation with jointing bays. Access is also an issue. Valve stations are spaced about 80 km apart, far exceeding cable pulling limits. Additional access points would be needed for installation and maintenance, increasing complexity and cost.

3.9.4. Bending and Structural Constraints

Gas pipelines were built for high-pressure transport, not for electrical cables, leading to mechanical incompatibilities during installation. Tight bends and non-linear paths often exceed the safe bending radius for HV cables, risking insulation damage and reduced reliability. Internal diameter changes and welded joints create obstructions that increase cable stress during pulling. Pipelines also lack regular access points for cable jointing, which are typically needed every 500 m to 1 km in underground power systems.

3.9.5. Fault Detection and Repair Complexities

Detecting and repairing faults in cables housed within a sealed pipeline is significantly more difficult than in conventional underground systems. Standard fault location methods, such as thumper testing, TDR, and thermal imaging, are compromised by the steel enclosure, bends, and limited access. These techniques are less effective or unusable in a pipeline environment. Faults cannot be excavated directly. Repairs require full excavation at predefined access points, increasing time and cost. While conventional faults can often be resolved within 24–48 hours, faults in repurposed pipelines could take weeks. Confined pipeline spaces also increase the risk of arc flash and internal heating during insulation failures, complicating fault response further.

In conclusion, the feasibility of repurposing gas pipelines for electricity transmission is severely constrained by thermal limitations, electromagnetic interference, installation challenges, mechanical incompatibilities, and fault detection difficulties. The concept may be viable only in limited scenarios, such as single-cable HVDC transmission, where electromagnetic and thermal issues are minimised.

3.10. Regulatory Landscape

Repurposing gas transmission pipelines for electricity use involves major regulatory challenges, not just technical ones. There is no established legal mechanism for converting a gas asset into an electricity asset. Any project would require bespoke approvals and coordination between Ofgem, the Health & Safety Executive (HSE), and National Gas. Key issues include licensing, safety, ownership, and planning requirements.

The following section outlines the key licensing, safety, ownership, and planning requirements that would need to be addressed for such a project to proceed.

3.10.1. Electricity Transmission & Distribution Regulations

The Electricity Act 1989 governs electricity generation, transmission, and distribution in the UK. It requires all operators to hold an Ofgem-approved licence. Gas pipeline owners cannot operate electricity assets without a licence transfer. Infrastructure changes may also affect asset valuation and price controls under Ofgem's RIIO framework.

3.10.2. Electricity Safety, Quality and Continuity Regulations (ESQCR) 2002

- Regulation 14: Requires underground cables to be adequately protected. A pipeline could serve this function, but additional measures such as fireproof barriers or internal ducting may be needed.
- Regulation 13: Stipulates that conductors must be insulated and properly earthed. Pipelines would require specialist bonding and insulation strategies to prevent induced voltages.
- Regulation 15: Requires the updating of utility mapping records when infrastructure is repurposed. Any pipeline converted to carry electricity must be properly registered to prevent third-party excavation risks.

3.10.3. Energy Networks Association (ENA) Technical Standards:

ENA TS 09-02 sets out requirements for underground cable protection and installation. Earthing and bonding standards must be followed, especially when using a steel pipeline as a protective enclosure.

3.10.4. Gas Pipeline Decommissioning & Asset Transfer Regulations

Under the Pipeline Safety Regulations (PSR) 1996, decommissioned pipelines must be purged, sealed, and made safe before repurposing. Structural modifications must be assessed for gas contamination or explosion risks. The HSE must confirm that decommissioning poses no safety risks before transfer to an electricity operator.

3.10.5. Regulatory Handover Challenges:

There is no standard process for converting gas pipelines to electricity use. Any transition would require coordination between Ofgem, HSE, National Gas, and the FSO. Repurposed pipelines must meet all ESQCR and RIIO-3 requirements, as if they were new electricity assets.

3.10.6. Planning & Environmental Considerations

Some modifications may fall under permitted development rights, but new access points, jointing bays, or ventilation structures may need full planning approval. Under EIA Regulations 2017, large-scale changes may require assessment, especially where heat, EMF, or soil impacts are expected. HSE rules require compliance with confined space entry and structural safety standards.

In conclusion, there is no defined process for converting gas pipelines to electricity use. Projects would need case-by-case approvals from Ofgem, HSE, and National Gas, with major clarity needed on ownership, safety, and planning.

3.11. A specific use case: HV conduit from offshore wind generation

A new offshore wind project could use HV or EHV DC cables to connect inland. A nearby decommissioned gas pipeline, running in the same direction, is being considered as a repurposed underground cable duct.

To be feasible, the pipeline must:

- Be decommissioned with nitrogen and not filled or sealed with concrete
- Be structurally sound with a suitable remaining service life
- Meet cable pulling and bending radius requirements
- Have suitable access points, with new ones added if needed
- Allow for fault access and diagnosis
- Meet all technical, regulatory, and environmental standards

Repurposing is viable **if** the pipeline meets structural, electrical, thermal, routing, access, and cost requirements.

3.12. Conclusion

66kV and 132kV networks are best suited for installation within gas transmission pipelines, given their alignment with typical transmission distances and limited access requirements. Pipeline size may restrict installations to a single cable, with multiple sets needing further assessment. Long-distance cable runs would require additional access points for pulling and jointing. The pipeline’s structural condition must support the cable’s full service life, though uncertainty remains around the long-term impact of AC corrosion. Any repurposed pipeline must meet ESQCR 2002 standards, and large-scale projects may trigger environmental assessments. Use as an HV conduit from offshore wind is a potential niche application, but only under specific conditions.

4. Business Case and Route to Market

This section explores the business case, route to market, and technoeconomic feasibility of the Alt Pipe concept and various technologies.

4.1. Business Model Assessments

After defining the various options for business models for each technology considered as part of this study, we evaluated the feasibility of repurposing decommissioned gas pipelines across various dimensions, including delivery model requirements, scalability, commercial viability (including assessing the applicability of each business model type), and regulatory considerations to complete an impact assessment to highlight the suitability of each technology.

The results of the impact assessment are presented below which outlines fibre, district heating, and aviation fuel as the strongest technological options for repurposing decommissioned gas pipelines.

Table 21: Impact Assessment Results

Parameter	Scoring					
	CAES	*Electrical Transmission*	*DH*	*Fibre*	*Water/ Wastewater*	*SAF*
Delivery Model Requirements	○	◕	●	◑	◕	◑
Scalability	○	◑	◔	●	◑	◕
Commercial Viability	○	◔	◑	◕	◔	◕
Policy and Regulatory Barriers	◔	◑	◕	◕	◑	◑
Rank	6	=4	=2	1	=4	=2

Key: ○ ◔ ◑ ◕ ●

Increasing suitability →

The key conclusions from the impact assessment are:

- Fibre has strong scalability and commercial viability with broadband expansion and moderate regulatory challenges.
- District Heating is viable with fewer regulatory barriers, though scalability is somewhat limited by the need for dual-pipe insulated systems and localised demand.
- Large pipeline capacity supports scalability for SAF, but viability depends on demand, blending preferences, and regulatory compliance with fuel safety standards.
- Water/wastewater solution is location-dependent with contamination and water quality regulations in the case for potable water supply.
- CAES has scalability and commercial challenges due to low energy storage capacity, and additional infrastructure requirements.
- There a several models through which electrical energy transmission can be deployed; however, from a commercial perspective the solution has challenges from overhead cabling being considerably cheaper alternative.

4.2. Cost Benefit Analysis (CBA)

To support the commercial viability scoring as part of the impact assessment defined above we have conducted techno-economic modelling based on various implementation approaches using [FES 2024 scenarios].

4.2.1. Methodology

There are several key considerations for the CBA:

- The counterfactual scenario assumes the cost associated with maintaining the assets that have been decommissioned.
- The baseline scenario assumed maintenance costs of decommissioned pipelines are avoided, and the scenario considers only 10% of the existing scenario is repurposed in the future.
- FES Forecasts are used to forecast fall in gas demand and therefore available network for decommissioning. This is done by assuming a non-core network. The non-core network is escalated by being linked to the fall in gas demand assumed across each FES scenario.
- We have presented the results in two different ways:
- On a per km of pipeline basis – this considers a normalised CBA regardless of the total length of the decommissioned network.
- Overall network of decommissioned assets basis – this considers the results which differ depending on the FES scenarios presented on the RHS of the slide.
- The business models considered for each technology as part of the CBA are outlined in the following two slides.

Additionally, there are various business models considered for the CBA with various business model options being identified for each technology considered as part of the project, each of which can have variations depending on the specific project and parties involved.

Therefore, there is no standard business model that can be considered for each potential technology, and it will be extremely project specific. This is due to location specific considerations such as demand for the technology and the soil composition, and the various operating models deployed across these technologies from the multiple stakeholders involved.

Here, we have opted for an approach that aligns with National Gas' business model preference, whereby they will not be the sole owner and operator of the technology/facility. The business models for each technology that are considered are defined in more detail below.

Table 22: Business Models Considered for the CBA

Technology	Business Model Considerations
CAES	Not considered as part of the CBA due to the findings outlined in Section 3 and Section 4.1.
Electricity Transmission	**<u>Pipeline Leasing</u>** Lease space within the pipelines to electricity transmission operators for installing cables. **Revenue:** As part of these assumptions, we have assumed that National Gas (NG) will be able to charge a rental fee for the pipeline infrastructure based on alternative routing costs (i.e., the avoided costs). **Costs:** To ensure leasing, National Gas will be responsible for the retrofitting of the pipeline ready for installation. Installation will therefore be the responsibility of the operator, as will O&M.
Heat Networks	**<u>Public-Private Partnership (PPP) Business Model</u>** **There are several key business models for DH each with variations within each group. One prominent model is the PPP model.** As part of this business model we have assumed that LAs own some of the assets (i.e., the energy centre) but partner with private sector entities for operation and heat delivery. **Revenue:** As part of these assumptions, we have assumed that National Gas (NG) will be able to charge a rental fee for the pipeline infrastructure based on alternative routing costs (i.e., the avoided costs) but is also likely to be expected to operate the pipeline. Furthermore, as the operator of the pipeline they will be reimbursed costs with an arbitrary margin. **Costs:** To ensure leasing, National Gas will be responsible for the retrofitting of the pipeline and O&M. Another private party will be responsible for the operation of the energy centre.
Fibre Optics	**<u>Leasing Pipeline Space</u>** There are two main models: leasing pipeline space to telecom providers or offering managed fibre services; however, due to lower appetite of National Gas in becoming an ISP the leasing model is considered. **Revenue:** This is determined by the level of capacity required based on domestic and commercial customer demand away from the core network at a minimum speed of 10 Gbps. This is combined with leasing rates for fibre. **Costs:** To ensure leasing of fibre capacity within the pipeline, National Gas will be responsible for the retrofitting of the pipeline and O&M.

	An independent service provider will be able to lease the capacity and will directly engage with the end customers.
Water	**Leasing Model for Water and Wastewater Transport** Water companies tend to own and operate their pipelines; however, leasing pipelines has been considered and there are potential end uses for industrial water supply. Combining this with the lower appetite of National Gas in becoming an ISP the leasing model is considered. **Revenue:** This is determined by a leasing rate per unit distance of pipeline. **Costs:** National Gas will be responsible for the retrofitting of the pipeline, whereas operation and O&M will be the responsibility of the water companies/independent operator.
Sustainable Aviation Fuel	**Leasing Model** The full-service model faces challenges in recovering fixed costs, mainly if throughput is low. Meanwhile, leasing models shift more risk and responsibility to an operator which provides the best approach for National Gas. **Revenue:** As part of these assumptions, we have assumed that National Gas (NG) will be able to charge a rental fee for the pipeline infrastructure based on alternative routing costs (i.e., the avoided costs). **Costs:** To ensure leasing, National Gas will be responsible for the retrofitting of the pipeline and to reduce the operational risk of the pipeline by the operator, will be responsible for sharing the fixed cost for operating the pipeline. Another party will be responsible for the operation of the pipeline and all the variable costs associated with it.

4.2.2. Results

As part of the CBA, fibre optics and aviation fuel stand out as the most promising options, while water and wastewater appear to be the least financially viable. Key insights include:

- Fibre optics requires a relatively low initial investment and demonstrates strong financial viability in the long-term, with increasing profitability over time off the back of stable revenue and a long lifetime for the solution.
- Aviation fuel has a high initial cost to retrofit the pipelines when compared to alternative solutions, but it delivers the highest returns over time.
- This is mainly attributed to a high level of avoided costs for install making it the most financially attractive option despite a shorter pipeline lifetime compared to other solutions.
- Electricity EHV and HV has a moderate retrofit cost. EHV offers a positive return over time for the leasing business model outlined, while HV has a negative return.
- However, the alternative install CAPEX from overhead pylons is a fraction of the costs for underground solution. Therefore, the alternative case for overhead pylons will be preferred by DNOs/iDNOs to the leasing model outlined here.
- Heat networks have a higher initial CAPEX cost which results in a long-term payback period.

- Water and wastewater both require substantial initial retrofitting costs to ensure compatibility which exceeds revenue received from leasing rates, making them the least viable options.

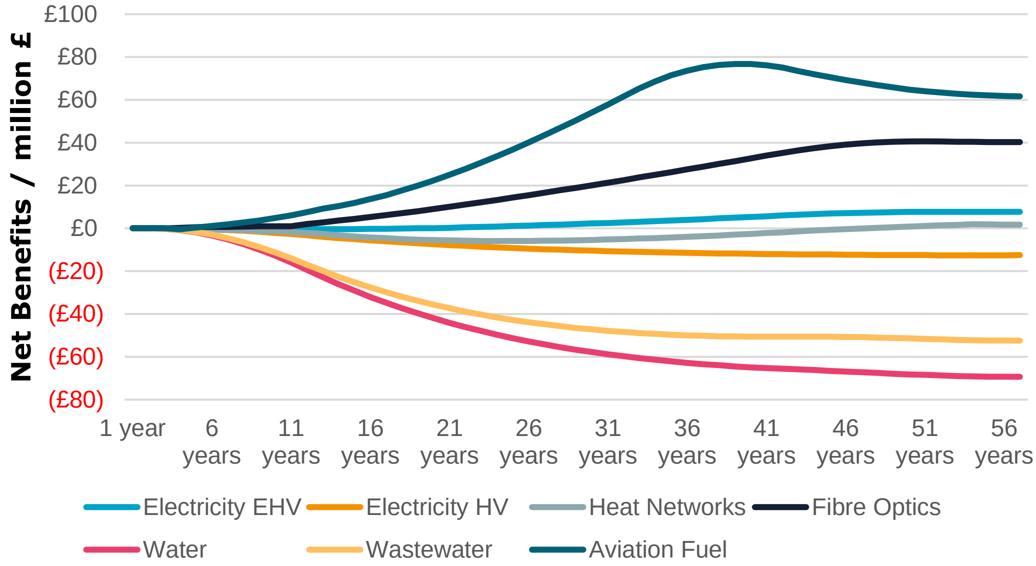

Figure 3: Discounted cumulative net benefits – base case 10% of the NTS repurposed

When considering various transitions away from gas usage as defined in FES 2024 scenarios, the rate of National Transmission System (NTS) decommissioning varies, influencing the uptake of alternative solutions.

The scenario results align with the Base Case trends outlined above, with key differences as follows:

- Faster gas transition benefits electricity and fibre, but harms projects associated with water and wastewater.
- Electric Engagement and Holistic Transition drive the fastest transition away from gas, accelerating pipeline decommissioning. These scenarios yield the highest returns for electricity and fibre-optic projects but result in the poorest outcomes for water and wastewater repurposing.
- Counterfactual Scenario closely mirrors the Base Case, with minimal NTS repurposing due to continued strong gas demand, limiting the adoption of alternative technologies.

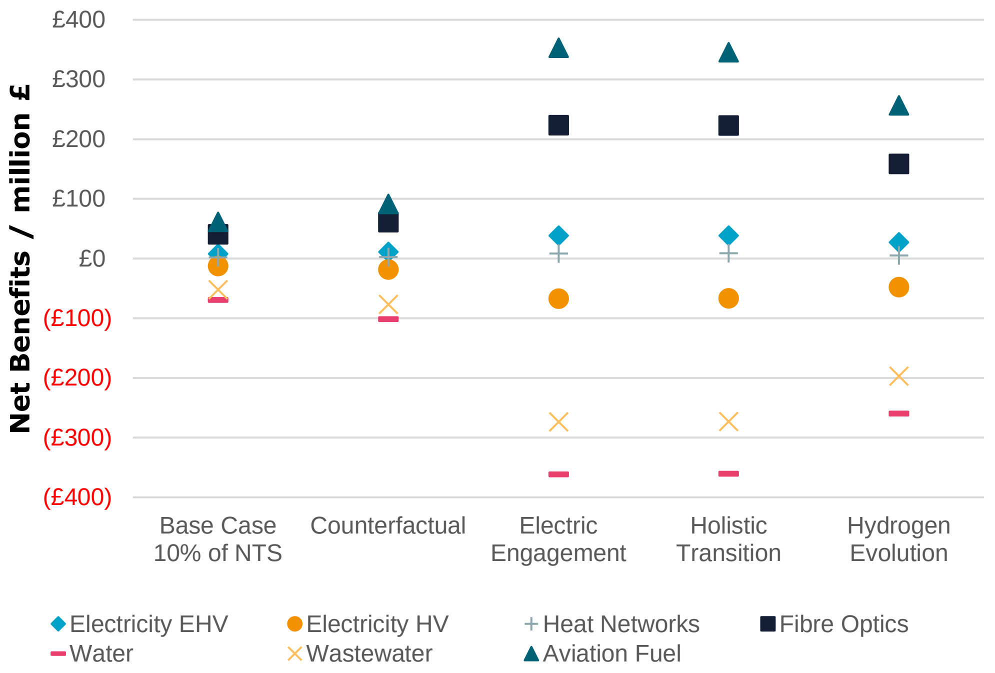

Figure 4: Lifetime Net Present Value (NPV) by Scenario

4.3. Conclusions and Next Steps

Conclusions

- **A high-level impact viability and costing assessment has been conducted for the following technologies as alternative solutions for existing gas pipeline repurposing. This includes the following technologies:**
  - District heating networks
  - Aviation fuel transportation
  - Compressed air energy storage (CAES)
  - Water (Potable water and wastewater)
  - Fiber cable
  - Electrical energy transmission
- **The strongest technological options for repurposing are fibre, district heating, and aviation fuel, which should all be considered as suitable technologies to be brought forward to Alpha phase.**
  - Fibre benefits from broadband expansion and ease of scalability, DH faces insulation and demand constraints limiting its scalability, whereas SAF depends on blending policies and fuel safety standards.
  - Those three technologies also show the greatest commercial viability of the solutions, with fibre and aviation fuel being the standout solutions.
- **The weakest solutions are water/wastewater** which are location-dependent, have limited viability and may encounter regulatory challenges, whereas **CAES** lacks storage capacity, and **electrical transmission** faces cost competition from overhead lines. In

particular CAES should not be considered further as a viable solution due to its challenges around scalability and commercial viability.

- **The business models deployed across the various sectors have a high variability** due to several operating models each with numerous variations, each of which has potential to be a feasible option.
  - We have only assessed the leasing business model which is considered the preference for National Gas; however, due to the specifics surrounding a business case, further refinement of the business model and benefits must be considered when discussing specific pipeline locations.
  - Some examples of specific site considerations include responsibility of O&M and the level of throughput for water/fuels.
- While these initial findings are based on an archetypal location, **there will be some variations in avoided costs depending on location of the pipeline** due to characteristics of the soil, etc. However, these variations are expected to be relatively small and independent of the infrastructure surrounding the pipeline due to the nature of the business model focussing purely on the leasing of individual pipelines.
- **Multi-utility solutions will further enhance profitability** with technologies such as aviation fuel and fibre being a feasible option to consider.

Next Steps

- **A more detailed CBA study shall be conducted for the shortlisted technologies, including other types of business models.**
  - Going forward National Gas may want to consider other business model types beyond purely leasing to third-parties. This may include the consideration of National Gas becoming a full-service provider (i.e., owner and operator model).
  - The variations of business models will impact the returns of any potential solution, and it could be more favourable for National Gas (albeit adding more risk as the business model becomes more complicated).
  - The CBA should be refined following the identification of pilot projects or test sites to validate technical and commercial viability will be required before wider implementation.
- **Regulatory impacts from the shortlisted technological solutions need to be explored further in Alpha phase** (beyond the high-level considered here) to realise the true cost and any operational impacts for any solution. Further discussions with regulatory bodies, potential partners, and industry stakeholders to refine feasibility and address policy challenges.
- **Explore potential co-location opportunities**, such as combining fibre with other solutions such as aviation fuel transportation, to maximise asset utilisation and revenue streams.

5. Stakeholder Engagement

This section explores key stakeholder perspectives on the feasibility of the Alt Pipe concept.

5.1. Stakeholder groups

In order to define our engagement approach for the Discovery phase of the project we mapped eight stakeholder groups according to their level of interest in the project and their power (fig. 5).

The highlighted groups were prioritised for engagement during the Discovery phase of the project.

For the priority groups, the aims of the engagement were:

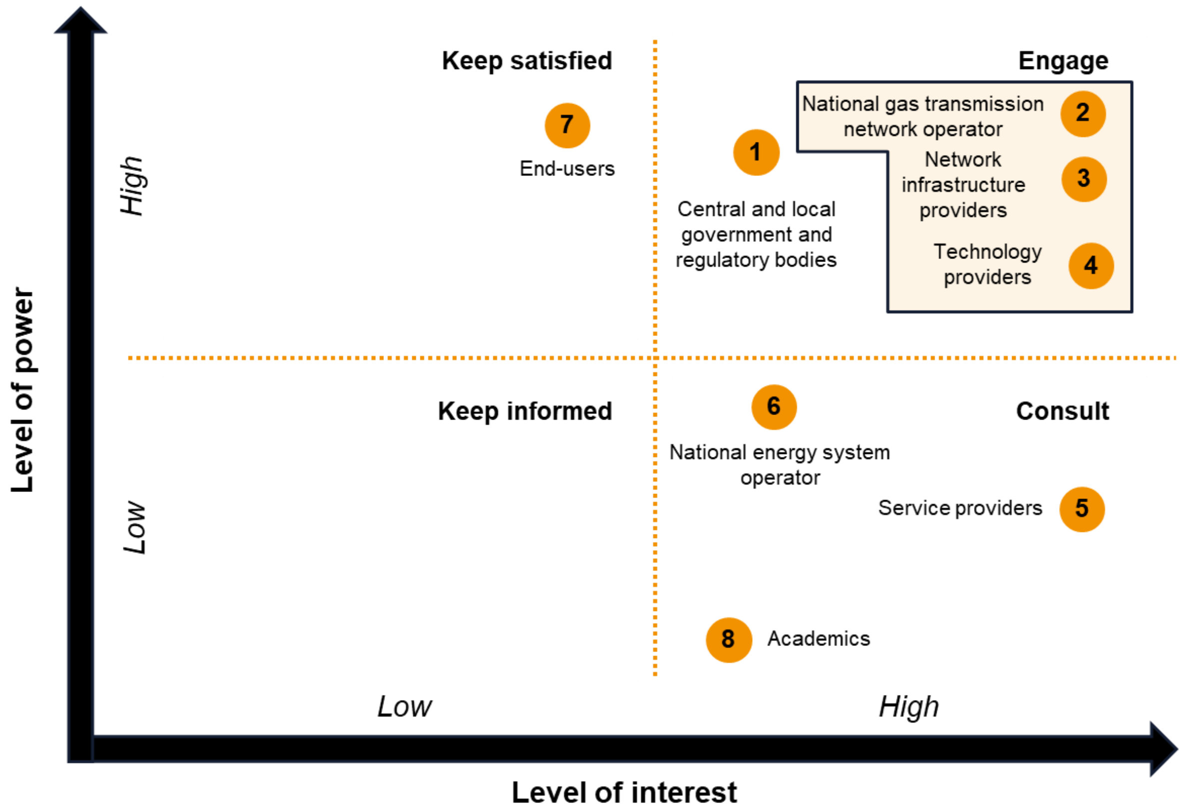

Figure 5: Stakeholder mapping

- Raise awareness of the concept and the project
- Test industry perception of the proposed solution, identify key challenges and requirements.
- Gather intelligence to feed into the business case development and technoeconomic assessment

Although a highly important stakeholder, we will not be directly engaging with Government and regulatory bodies during the Discovery phase. This is because there were no significant regulatory barriers foreseen. We will engage with regulatory bodies and local authorities during the Alpha and Beta phases of the project.

Network infrastructure providers

Owners and operators of electricity, gas, heat, fuel, water, fibre optics network infrastructure. Infrastructure providers are a key stakeholder group as this project is focused on utilising or integrating their network assets. This group can provide the following insights:

- **Cost Analysis:** Estimates for retrofitting pipelines for specific uses like heat networks or fibre optics.
- **Business Model / Revenue analysis:** Discussion of key business models, identify any alternative BMs, estimates on revenues through service provision / leasing and various pricing models for service provision.
- **Demand:** Insights into potential areas of need / suitability
- **Design Expertise:** Best practices for adapting infrastructure to alternative applications.
- **Maintenance Challenges:** Insights into potential operational and lifecycle maintenance needs. Estimation of costs / key considerations.

In this Discovery phase, we spoke to fibre and heat network providers, as well as a DNO, a GDN, and a pipeline trade association. In the Alpha phase, we hope to speak to water infrastructure providers.

Technology providers

Organisations that develop, manufacture or supply the equipment or systems that would be required to repurpose the pipeline. Technology providers could be involved in this project if alternative solutions require new technologies to be developed.

- Technical Feasibility: Assess the suitability of pipelines for applications like heat networks, CAES, or fibre optics.
- Innovation / product development: Share advancements in materials, equipment, and software for optimizing new uses.
- Cost-Effective Solutions: Provide modular or scalable technologies tailored to project needs.

National gas transmission network operator

This project focuses on alternative uses of the gas transmission network. National Gas are the sole owner and operator of the national gas transmission network. As a project partners, their role in the project is critical:

- Technical Knowledge: Detailed information on pipeline integrity, material properties, and geographic layout.
- Operational History: Data on historical usage, wear, and existing pressure ratings of pipelines.
- Decommissioning Protocols: Expertise in safely transitioning pipelines from gas transmission to alternative uses.

5.2. Stakeholder engagement summary

Technical Feasibility

Stakeholders expressed broad interest in repurposing decommissioned gas infrastructure for uses such as district heating (DH), fibre optic cabling, alternative fuels, and energy resilience.

From a DH perspective, the feasibility is promising but conditional. One heat networks expert highlighted that gas transmission pipes—though structurally robust—are not insulated and lack the twin-pipe configuration typically required. Stakeholders from the gas sector suggested that larger distribution mains may be suitable, whereas smaller local pipes would be less useful. However, even using the pipeline trenches as pre-established routes could present significant value by avoiding excavation costs. That said, alignment with zones of high heat demand is key.

On the telecoms front, fibre installation within or alongside pipelines was seen as technically viable, especially in trunk network scenarios. However, accessibility and operational control were flagged as essential—telecom providers need predictable access points, low-risk environments, and commercial terms that don't expose them to unexpected costs or evictions.

Electricity network stakeholders raised technical concerns regarding pipeline condition, noting that in some cases, older cast-iron pipes had degraded so extensively that gas was effectively flowing through the surrounding clay.

Economic Viability

The clearest theme across all stakeholders was the importance of location. While the reuse of pipeline corridors has potential to reduce infrastructure costs, this is only valuable if there is an identified need—whether heat, power, data, or fuel—along that route.

One gas network representative pointed to data centres as a compelling use case. These facilities face huge challenges accessing grid capacity, with some quotes for connection infrastructure rendering projects unviable. In this context, access to repurposed gas pipelines—for either backup power or integrated services like fibre—could offer a compelling alternative, provided the location is suitable and interconnection issues can be resolved.

There were also comparisons drawn to private wire arrangements in electricity networks, where independent operators manage infrastructure that links a site (such as a housing development or data centre) to the main grid through a single regulated point. This model was seen as potentially transferrable to gas or multi-utility scenarios.

Policy and Regulatory Considerations

Policy and regulation emerged as a critical theme. Many stakeholders flagged that existing market rules limit participation, particularly for regulated electricity networks, which cannot generate or store energy. This points to a need for evolving governance that allows for partnership models and more flexible asset ownership.

Operational risk and liability were flagged as key concerns. For example, one stakeholder raised the issue of land access rights—if a pipeline was originally leased for "gas use only", it may not be legally straightforward to reuse it for fibre, fuels, or heat. Thousands of leases may need renegotiation, adding cost and complexity.

From a telecoms perspective, stakeholders emphasised the importance of certainty. Fibre is a low-cost product with high operational sensitivity—once installed, it becomes extremely expensive to relocate due to the value of the data it carries. Therefore, any shared infrastructure solution must include long-term guarantees, clearly defined rights of access, and minimal disruption risk.

Several participants also highlighted the importance of a transparent, national asset register that includes both active and decommissioned pipelines. This would allow other sectors—telecoms, data, heat, fuel—to proactively assess where infrastructure reuse might be viable.

Customer and Industry Demand

While some stakeholders expressed caution about overstating market readiness, others identified clear demand signals emerging across sectors.

- District Heating: Suitable where major heat sources (e.g. EfW, industrial waste heat, or data centres) are within close proximity to heat demand. Success depends on location and the potential to avoid new excavation.
- Fibre: Most viable in long-haul trunk scenarios. The value proposition increases in rural areas or areas with limited existing duct infrastructure.
- Data Centres: Facing high electricity connection costs and delays. Repurposed pipeline routes could support hybrid solutions involving gas or distributed backup generation.
- Sustainable Fuels: Some stakeholders saw potential for pipelines to transport or store fuels like SAF, especially near production hubs or import terminals. However, issues such as blending, traceability, and aviation quality standards remain key considerations.

Others pointed to the possibility of multi-utility corridors, where heating, power, and fibre might share pipeline infrastructure. While technically promising, this was seen as more likely to work on new developments than through retrofitting legacy assets.

Across all interviews, the underlying message was that demand will depend on early-stage planning, cross-sector coordination, and clear information sharing. Stakeholders want to know what assets are available, what conditions apply, and how partnerships could be structured—preferably before infrastructure is decommissioned, not after.

5.3. Conclusion

Stakeholder engagement revealed a clear appetite for exploring alternative uses of decommissioned gas pipeline infrastructure—but with strong consensus that success will hinge on **pragmatic, location-specific solutions**, **cross-sector collaboration**, and **clarity on regulatory and commercial frameworks**.

While technical feasibility is broadly accepted—particularly for district heating corridors, fibre optic cabling, and niche fuel applications—barriers remain in terms of access rights, asset condition, and market readiness. Opportunities such as supporting data centres, enabling telecoms rollout, or unlocking hybrid energy systems were repeatedly flagged, but all rely on timely planning and coordination between stakeholders.

There is also a recurring theme around **missed opportunity risk**: without proactive information-sharing and policy alignment, valuable infrastructure could be decommissioned before its reuse potential is fully explored. Stakeholders called for national-level asset mapping and clearer guidance on what regulatory changes would enable reuse, especially in support of net zero infrastructure delivery.

Ultimately, the transition to a decarbonised, digitally connected energy system requires making better use of what already exists. Decommissioned gas pipelines may offer a low-cost, low-carbon pathway to enable new services—if the sector can move quickly, collaboratively, and strategically to make it happen.