Northern Gas Networks

A23.L - NGN RIIO-2

Investment Decision Pack
Gas Holder Demolition

we are the network

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2. Introduction

This Engineering Justification paper details our proposals for investment on our Gas Holder assets during RIIO-2 and acts as a narrative to be used in conjunction with the accompanying Cost Benefit Analysis. It explicitly follows Ofgem's guidance and is set out in accordance with the headings therein.

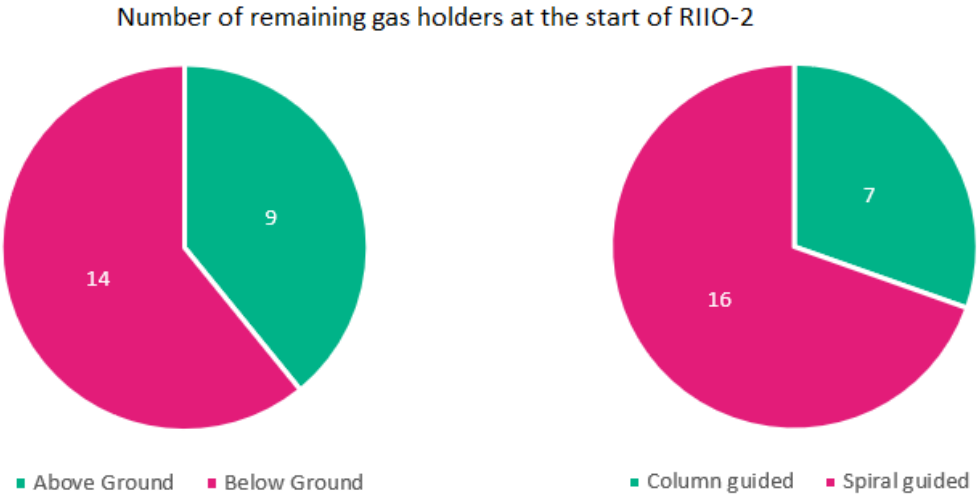
Our gas holders are no longer in use, continue to hold risk and deliver no value to our customers. During RIIO-1 we undertook a demolition programme where by the end of the period we will have demolished 23 of the 47 remaining gas holders. During RIIO-2 we are planning to demolish the remaining 24 on our network.

This engineering paper aims to outline the justification for our proposed RIIO-2 gas holder demolition investment, detailing our asset management decision making process during which we analyse risk and value and trade-off between different intervention options. It explains the drivers for investment, the inputs and assumptions used in our Cost Benefit Analysis and how our proposed investment benefits our customers and stakeholders.

3. Equipment Summary

Gas holders are large assets originally constructed on gasworks sites to store gas and later used to balance the network. They generally consist of two parts, a tank which contains water and a vessel or lift which contains the gas which rises and falls depending on the volume of gas stored. No gas holders remain in active service in the UK as low pressure gas storage is no longer required due to improved storage capacity elsewhere in the network.

Our gas holders were largely constructed from late 1800's to mid-1900's with our oldest gas holder on our network, Hendon No. 3, being constructed in 1883. At the start of RIIO-1 we had 47 non operational gas holders and by the end of the price control we will have demolished 23 of these leaving 24 gas holders remaining on our network at the start of RIIO-2. The chart below shows the types of the gas holders which remain at the start of RIIO-2:



Due to their appearance and historically significant elements of their construction, we have two gas holder frames which are nationally listed under the Planning (Listed Buildings and Conservation Areas) Act 1990, one at Carlisle and one at Hendon. This means we have a legal responsibility to prevent deterioration and damage to the structures and the legislation gives the local planning authority and the Secretary of State certain rights if it is felt this responsibility is not being met. Significant fines can be levied if it is considered we are not maintaining these assets. We have demolished the tank at Carlisle leaving only the frame however at Hendon both the tank and the frame remain. Carlisle framework is not included in our gas holder asset numbers above however Hendon is as we plan to demolish the tank during RIIO-2 leaving the frame still standing. Our preference is to sell the sites as this will save a significant cost for maintaining the structures, however should this not be possible, we will need to carry on maintaining the listed structures in compliance with our licence obligations and health and safety requirements.

Further to this, we have three holders that are locally listed. We are in dialogue with the relevant local councils to ensure we can demolish these holders during RIIO-2 however if these holders are 'promoted' to be nationally listed, then it would mean we would be required to continue to maintain the assets and would be unable to demolish them.

4. Problem Statement

Why are we doing this work and what happens if we do nothing?

All our remaining gas holders are non-operational and delivering no value to our customers, however under our Pipelines Safety Regulations (1996), we have an obligation to maintain the structures to ensure we manage health and safety and environmental risks.

A typical gas holder generally contains more than 10,000m3 of contaminated water within its below ground tank. This water contains an array of dissolved hazardous pollutants associated with the former town gas manufacturing and purification processes undertaken on site including cyanide, benzine and polycyclic aromatic hydrocarbons. In addition, there is a layer of sealing oil on the water surface and a layer of sludge at the base of the tank which holds similar hazardous materials in higher concentrations, as well as containing lead associated with old paint which has flaked off the holder metal work and settled out in the tank. These contaminants are currently contained within the tank structures however the assets are considerably beyond their originally anticipated design life and degrading structures risk the release of these contaminants into the environment.

As the gas holder structure deteriorates it becomes weakened and could buckle under its own pressure or partially collapse where segments fall away from the structure resulting in a risk of injury or death from a falling object. In addition, as stair cases and roof sheets deteriorate, the risk of injury from a fall increases should an operative or a member of the public access to the structure.

For these reasons we want to demolish our gas holders to avoid increasing health and safety and environmental risks and ongoing maintenance and repair costs.

What is the outcome that we want to achieve?

We want to demolish the 24 remaining gas holders during RIIO-2 to remove the risks associated with these assets. The two remaining gas holder frames which are nationally listed we would like to sell to

pass on the associated costs of maintaining those structures however if this is not possible we will continue to maintain the frames to ensure they remain structurally sound.

How will we understand if the spend has been successful?

By delivering the full demolition programme within RIIO-2.

4.1. Narrative Real Life Example of Problem

Case Study 1 – Minton Lane Gas Holder

The project consisted of the demolition of one below ground gas holder including removal and disposal of the welded tank, jet booster house, redundant pipework and backfilling of the void with recycled aggregate. Whilst on site it was discovered that the gas holder was constructed with a wooden support structure rather than the usual metal umbrella structure found in most gas holders. The discovery of this delayed the project whilst we developed a plan to execute the safe removal of the holder roof and wooden support structure. Working with our contractors and structural engineers we were able to achieve this task by bringing two cranes on site whilst we systematically took down the structure. The project was completed, the void backfilled, and land reinstated thus removing future maintenance costs and health and safety and environmental risks.

Case Study 2 – Penrith Gas Holder

The project consisted of the demolition of one above ground gas holder. Gas holder tanks are filled with water and over time vegetation and other materials fall through the holder cups into the tank and settle on the tank floor creating a sludge like substance. During demolition this sludge requires appropriately and safely disposing of. However, prior to dewatering of the tank we are unable to sample and test the sludge to understand its constituents and the appropriate disposal route and costs. At Penrith the sludge discovered to contain abnormally high levels of cyanide. This required a specialist waste management contractor to safely dispose of the sludge and increased the time and costs associated with it. This shows the inherent risks associated with pricing projects which contain elements which are unknown until you are on site. We have since tried innovative methods of sampling the sludge before dewatering of the tank but to date have not been successful.

Case Study 3 – Clean to Green Innovation Project

We trialled an innovation project to remove the risks associated with man entry into a confined space during cleaning and disposal of sludge on the tank floor. Working with a local business we developed a tracked hydraulic robotic dozer to undertake the cleaning task without man entry. Unfortunately, the dozer struggled to negotiate the steep dumpling profile within the below ground holder at Redheugh and the project was not deemed a success. However, we are continuing to look at new and innovative methods to make how we work safer for our operatives and contractors.

4.2. Spend Boundaries

The only costs considered in this paper are those directly related to gas holder demolition and include overheads. Land remediation and site rationalisation following demolition have not been considered in this paper. Costs associated with the maintaining the nationally listed holders are included within the Maintenance costs.

5. Probability of Failure

The probability of Failure (PoF) is the probability an asset will fail at a given point in time. When justifying our RIIO-2 capital investment, our Cost Benefit Analysis uses expertly elicited failure rates due to there being little industry data on failure of gas holders.

Failure Modes

We have identified two primary Failure Modes for this asset which include:

Total or partial collapse – failure of the tank structure or framework usually due to corrosion of the rivets and bolts failing under stress

Hazardous leak – failure of the tank structure or rainwater overflow resulting in a leak of hazardous materials

Failure Rates

The Failure Rate for an asset is the frequency of failures at a given point in time, typically measured as the number of failures over a year. The failure rates used in our Cost Benefit Analysis are detailed below and show the expected number of failures during the year 2019/20. We have assumed a straight-line deterioration rate of 6.7% each year and have indicated the number of years we would expect one failure to occur using the stated failure and deterioration rates.

Health & Safety

- Non-Fatal injury from a fall (operative) – **0.0100** *(one in 30 years)*
- Non-Fatal injury from a fall (public) – **0.0010** *(one in 300 years)*
- Fatality from a fall (operative) – **0.0030** *(one in 90 years)*
- Fatality from a fall (public) – **0.0011** *(one in 270 years)*

- Non-Fatal Injury from a falling object (operative) – **0.0033** *(one in 90 years)*
- Non-Fatal injury from a falling object (public) – **0.0011** *(one in 270 years)*
- Fatality from a falling object (operative) – **0.0011** *(one in 270 years)*
- Fatality from a falling object (public) – **0.0003** *(one in 810 years)*

Compliance

- Rainwater overflow oil leak fine – **0.0500** *(one in 20 years – not affected by the deterioration rate)*
- Damaged tank oil leak fine – **0.0100** *(one in 30 years)*

5.1. Probability of Failure Data Assurance

As we do not have actual data on gas holder deterioration and failure, we have derived the values used in our Cost Benefit Analysis from elicitation with industry experts. We have been conservative with the failure rates so to not exaggerate the benefits delivered.

In addition, we have undertaken sensitivity analysis on both the failure rates and the deterioration rate to understand if significant changes in these values would change the outcome of the Cost Benefit Analysis. If the sensitivity analysis does not highlight major differences in the Net Present Value, Payback or which option is preferred, this will provide a high confidence that our Probability of Failure data is not significantly sensitive to make a difference to the outcome we are seeking to deliver through this programme of work.

6. Consequence of Failure

The two main risks identified are health and safety and compliance risk.

Health & Safety

Our operatives must access the gas holders to perform planned maintenance tasks. As the gas holders deteriorate the risk of a fall from height increases due to the increased levels of corrosion to the structure such as on the stair cases, handrails, walkways and roof sheets. Although our sites are secured by a 2m high palisade fence and locked gates, there is also a risk that a member of the public could access the gas holders. The values used in our Cost Benefit Analysis for health and safety incidents are in accordance with the values proposed by Ofgem.

We have identified the following health and safety consequences associated with gas holders:

- Non-Fatal injury from a fall (operative)
- Non-Fatal injury from a fall (public)
- Fatality from a fall (operative)
- Fatality from a fall (public)
- Non-Fatal Injury from a falling object (operative)
- Non-Fatal injury from a falling object (public)
- Fatality from a falling object (operative)
- Fatality from a falling object (public)

The values used for non-fatal injury and fatality are in accordance with the NARMS methodology and Ofgem's Cost Benefit Analysis guidance.

Compliance

Our gas holders contain a large volume of water within the tank with an oil film on top. Over time this oil film emulsifies with the water to form oily water and vegetation and grease used in the maintenance process fall in through the gas holder lifts and causing sludge to form on the bottom of the tank. We have previously found the sludge to contain hazardous constituents such as elevated levels of metals, mercury, cyanide, arsenic and cadmium.

We have identified the following compliance consequences associated with gas holders:

- Rainwater overflow oil leak fine
- Damaged tank oil leak fine

The values used for environmental fines are taken from industry recognised independent non-departmental public body The Sentencing Council responsible for developing and monitoring sentencing guidelines. Within these guidelines NGN would fall within the large organisation bracket and in the event of a pollution incident would classify under the Negligent category 2 or 3 where fines range between £35k and £350k. For our Cost Benefit Analysis, we have assumed an average fine of £100k.

7. Options Considered

Types of Intervention

As the gas holders are non-operational there are only three types of intervention available:

Maintenance and repair – pre planned inspections and reactive repair works to ensure the ongoing integrity of the structure. This will include periodic grit blasting, weld repairs and repainting of the frame.

Removal – where we no longer require an asset, or we can manage our network in a more efficient manner we decommission and dispose of the asset from our network.

Land sale – this is generally the preferred option, however there is usually little interest in these sites due to their location and the fact there is a gas holder on the site.

Future Energy Pathways

We have gone with the default assumption of current assumed proportion of methane CO2 in natural gas projected forwards due to uncertainties in the potential energy pathways and because this is reflective of the current gas quality legislation. We acknowledge that significant changes to gas demand or the allowed methane content of gas, for example due to the blending with or conversion to hydrogen, would impact some of our proposed investments in RIIO-2 however it will make no difference to our proposed Gas Holder Demolition programme. This is because the primary drivers for investment are health and safety and financial and since the assets are no longer connected to our network, we have assumed no carbon benefits and therefore we are not able to model changes in the methane content of gas in our CBAs. Our strategy therefore represents a no regrets investment programme that is consistent with net zero and will deliver value to customers whether a hydrogen or electrification pathway is chosen.

Option Analysis

We have considered three options which have undergone a review of risk and value to determine the optimal solution for our customers. The investment options considered for gas holders are:

7.1.1. Baseline – Do nothing / minimum

This option is used as the baseline for which all other options are measured against. It does not include nay capital investment but instead considers the cost of ongoing maintenance activities and repairs. There are no direct benefits accrued under this option however it does include societal impacts associated with environmental incidents, fatality and injury.

7.1.2. Option 1 – Demolish all remaining gas holders in RIIO-2

This involves removing the entire structure and leaving the land in the position to be re-used or sold. The basis for the cost estimate/unit cost is historical costs. The perceived benefits of this option are to remove future liabilities and the removal of health and safety risks associated with the asset. We expect the programme to be delivered evenly over the five-year period.

7.1.3. Option 2- Deferred Investment

This option considers deferring investment until RIIO-3. The option delivers the 'do nothing / minimum' solution during RIIO-2 and then demolishes the holders during RIIO-3.

7.2. Options Technical Summary Paper

Option Title	First Year of Spend	Final Year of Spend	Volume of Interventions	Design Life	Total Cost
Baseline	-	-	-	-	-
Demolish all remaining gas holders in RIIO-2	2021/22	2025/26	24	n/a	£15.99m
Deferred Investment	2021/22	2025/26	0	n/a	£0.00m

7.3. Options Cost Summary Table

We have used our historic actual costs of eighteen gas holder demolitions during RIIO-1 to calculate our unit costs for RIIO-2 as there has been enough variance in the projects delivered to date in RIIO-1, such as type, construction, location, size etc. to calculate a robust cost estimate. For added accuracy we have calculated two unit costs, one for above ground and one for below ground as this factor is a primary cost driver due to the added requirement to backfill the hole left when demolishing a below ground gas holder. We have calculated the unit cost by volume (mcm) to account for the size of the holders left to demolish and provide a more accurate forecast cost.

The table below shows the eighteen gas holders demolished to date in RIIO-1 along with the type volume and unit cost. Note – we have note included the costs for St. Anthony's gas holder demolition as we backfilled the gas holder for free as part of a trial which proved to be unsuccessful due to the length of time it took to backfill. We do not expect any below ground gas holders will be backfilled for free again and so have removed this unit cost from our analysis.

Holder Name	Type	mcm	£m	Unit Cost (£/mcm)
Ayres Quay	Below Ground	0.027	£0.48	£17.80
Elswick	Below Ground	0.034	£0.66	£19.39
Minton Lane	Below Ground	0.034	£0.69	£20.42
Redheugh	Below Ground	0.036	£0.43	£11.91
Redheugh	Below Ground	0.080	£0.95	£11.91
Redheugh	Below Ground	0.049	£0.58	£11.91
St. Marks	Below Ground	0.045	£0.65	£14.48
Tindale Crescent	Above Ground	0.073	£0.43	£5.86
Clay Flatts	Above Ground	0.030	£0.37	£12.42
Curlew Road	Above Ground	0.062	£0.28	£4.47
Elswick 3	Above Ground	0.069	£0.46	£6.59
Howdon 2	Above Ground	0.063	£0.44	£7.03
Howdon 3	Above Ground	0.077	£0.54	£7.03
Rome Street	Above Ground	0.048	£0.53	£10.95
Old London Road	Above Ground	0.012	£0.49	£40.44
Portrack Lane	Above Ground	0.075	£0.44	£5.83
Meadow Lane 3	Above Ground	0.077	£0.45	£5.80
Meadow Lane 5	Above Ground	0.075	£0.43	£5.80
RIIO-1 Average (below ground)				**£15.40**
RIIO-1 Average (above ground)				**£10.20**

The below table shows the 24 remaining gas holders to be demolished along with the volume and forecasted cost using the average unit costs delivered in RIIO-1.

Holder Name	Type	mcm	Unit Cost (£/mcm)	£m
Canal Road 5	Below Ground	0.024	£15.40	£0.37
Canal Road 6	Below Ground	0.026	£15.40	£0.40
Ripon Road	Below Ground	0.024	£15.40	£0.37
South Gosforth	Below Ground	0.075	£15.40	£1.16
Oyston Street	Below Ground	0.036	£15.40	£0.55
Hendon 3	Below Ground	0.023	£15.40	£0.50
Hendon 4	Below Ground	0.038	£15.40	£0.59
Hendon 5	Below Ground	0.062	£15.40	£0.95
Birksall 1	Below Ground	0.068	£15.40	£1.05
Birksall 2	Below Ground	0.047	£15.40	£0.72
Birksall 3	Below Ground	0.054	£15.40	£0.83
Gas Works Street	Below Ground	0.109	£15.40	£1.68
Bankside 5	Below Ground	0.049	£15.40	£0.75
Bankside 8	Below Ground	0.106	£15.40	£1.63
Gas Works Road 1	Below Ground	0.026	£15.40	£0.40
Gas Works Road 3	Below Ground	0.028	£15.40	£0.43
Sheepscar	Below Ground	0.062	£15.40	£0.95
Heworth Green	Below Ground	0.052	£15.40	£0.80
Crossgates	Above Ground	0.021	£10.20	£0.21
Moorfield Road	Above Ground	0.016	£10.20	£0.16
Cleckheaton	Above Ground	0.026	£10.20	£0.27
Anderson Road	Above Ground	0.019	£10.20	£0.19
Mulcture Hall	Above Ground	0.020	£10.20	£0.20
New Wortley	Above Ground	0.078	£10.20	£0.80
RIIO-2 Total Expenditure				**£15.99**

8. Business Case Outline and Discussion

8.1. Key Business Case Drivers Description

Option 1 – Demolish all gas holders in RIIO-2 – This option has a positive Net Present Value after only five years which proves that demolition of the gas holders is overall beneficial for our customers. The total Net Present Value compared to the baseline after 50 years is £629m. There are no risks associated with this option as demolition of the gas holder removes all the risk. The total forecast expenditure is also low as once the gas holder is demolished there are no ongoing maintenance costs required except from monthly site security inspections and the cost of maintaining the frame at Hendon Gas Holder No. 3 which cannot be demolished due to listing status. The primary benefit driver is that of a fatality from a fall (operative) which has a low PoF of 0.4% in the first year however a high cost of consequence (c.£17m).

Baseline Sensitivity 1 – We have undertaken sensitivity analysis on the failure rates to see what effect this has on the benefits of our proposed investment. This sensitivity divides all the failure rates by a factor of ten, which is considerable reduction in the failure rates, for example the PoF of an operative fatality from a fall in Option 1 is once in every 90 years and in this sensitivity, it changes to once in every 900 years. This option still has a positive Net Present Value of £30m and provides a pay back within 25 years. The primary benefit driver is now the avoided cost from not having to undertake maintenance of the tank and frame. This sensitivity analysis shows that even when our Probability of Failure data is significantly reduced our preferred option of demolishing all gas holders within RIIO-2 still delivers clear benefit to our customers and does so within a reasonable timeframe.

Baseline Sensitivity 2 – We have also undertaken sensitivity analysis on the deterioration rate to see what effect this has on the benefits of our proposed investment. This sensitivity reduces the deterioration rate from 6.7% each year to only 1% each year. This option still has a positive Net Present Value of £81m and provides a pay back within 7 years. This sensitivity analysis shows that even when our deterioration rate is significantly reduced our preferred option of demolishing all gas holders within RIIO-2 still delivers clear benefit to our customers and does so within a good timeframe.

Option 2 – Deferred investment – This option has a positive Net Present Value after ten years with a total Net Present Value after 50 years is £607m. This option although is still beneficial compared to the baseline position, does not have as much benefit accrued to it as Option 1. This is because the benefits of gas holder demolition are removal of risk, and therefore the sooner this risk is removed then more benefits can be accrued. This option shows that there is no point delaying investment to remove these assets if the programme of work can be delivered in a safe and efficient way.

8.2. Business Case Summary

As per the agreed cost benefit analysis framework, total costs and risk under each of the options is compared to the total costs and risks under the baseline. The table below details the headline business case metrics to allow a high-level comparison of the options.

Options	Total RIIO-2 Forecast Expenditure (£m)	NPV (relative to baseline) £m		Payback Period (years)
		2030	2070	
Baseline – Do nothing / minimum	£1.8	-	-	-
Option 1 – Demolish the holders in RIIO-2	£17.8	£17.3	£628.7	5
Option 2 – Deferred investment	£3.0	-£0.8	£606.7	10

(Note – the expenditure numbers above include maintenance costs associated with the remaining holders until they are all demolished. Therefore, the expenditure in Option 1 does not equal the cost of demolishing the holders)

Option 1 to demolish the remaining 24 gas holders in RIIO-2 is the best solution which provides the greatest benefit to our customers and offers the quickest return on their investment.

We are confident that we have the ability and resource to be able to complete all 24 gas holder demolitions in RIIO-2 because we have a dedicated team with years of experience in delivering these types of projects. During RIIO-1 we have delivered a gas holder demolition programme in one year of seven holders which further evidences that the workload proposed for RIIO-2 is manageable.

9. Preferred Option Scope and Project Plan

9.1. Preferred Option

The preferred option is to demolish all 24 of the remaining holders in RIIO-2 and maintain the two gas holders which are listed.

9.2. Asset Health Spend Profile

£m (2018/19 prices)	2021/22	2022/23	2023/24	2024/25	2025/26	Total
Workload	5	5	5	5	4	24
Forecast Expenditure	£3.04	£3.15	£3.32	£3.71	£2.77	£15.99

The total forecast capital expenditure for Gas Holder Demolition has been included within this Cost Benefit Analysis and can be referenced back to the following documents:

- RIIO-2 Business Plan – Tables 6.5, 6.6 & 6.8
- RIIO-2 Business Plan Data Tables – Table 2.19
- A23.L - NGN RIIO-2 Investment Decision Pack – Gas Holders - CBA

9.3. Investment Risk Discussion

This is a small asset class (only 24 assets) where we are proposing on demolishing all remaining gas holders in RIIO-2. There is inherent risk in the unit cost as the content of the tank is unknown. However we have managed this risk during RIIO-1 and we expect to be able to manage the risk in RIIO-2 with a unit cost derived from RIIO-1 projects. We do not believe there are other significant Investment Risk factors which are application.