Cadent
Your Gas Network

Appendix 09.11
Offtakes & PRS Odourisation Systems
RIIO-2 Spend: £XXXXm

Investment Decision Pack Overview

This Asset Health Engineering Justification Framework outlines the scope, costs and benefits for our proposals. We have prepared an Engineering Justification Paper (EJP) and a Cost Benefit Analysis (CBA) for the Local Gas Treatment (Odourisation) assets. A brief overview is provided below.

Overview

This investment case covers the Local Gas Treatment (Odourisation) assets at Offtake sites. We have assessed a number of options for investment in these assets, either based on detailed engineering studies or on computerised risk models. The key options are:

- A top-down approach, based on current condition and system redundancy, using engineering and asset strategy judgement has been conducted.
- The minimum level of investment to maintain stable risk (as identified from modelling)
- The level of investment that would maximise whole life benefits (as identified from modelling)

We have also considered some further scenarios as part of sensitivity testing and analysis.

Our preferred RIIO-2 option is to review and trial two alternative odourisation systems (new technology) in RIIO-2 at a low flow & high flow site, to inform the RIIO-3 investment plan.

- Overall costs of £XXXXk have been derived from an Engineering paper provided to the RIIO-2 team. This has been split 40/60 respectively for Walesby (low flow) & Blackrod (high flow) Offtake sites, to account for the size and capacity of the sites.
- The trial is to operate over the full 5 years, with the majority of the work occurring during years 2 & 3 to support design and installation.
- The investment at Blackrod generates significant benefits as the population it serves is large.

The following table sets out a summary of the proposed RIIO-2 investment:

	Proposed pilot site	2021/22	2022/23	2023/24	2024/25	2025/26	Total
EA	None	Redacted due to commercial sensitivity					
EM	Walesby						
Lon	None						
NW	Blackrod						
WM	None						
Total							

The sites selected, are indicative, and are subject to change in RIIO-2, once further studies have been completed to inform the trials.

Summary of preferred option	£m
RIIO-2 Expenditure	Redacted due to commercial sensitivity
NPV	

Material Changes Since October Submission

Document has been updated into 2018/19 prices.

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2. Introduction

This document covers the investment in gas local treatment or odourisation systems, that are located at our NTS offtake sites. This system accurately doses a stenching agent to the gas; this distinctive odour is a critical safety feature, ensuring that any gas leaks are detected quickly. Strict guidelines around the control of these safety-critical systems are provided in GS(M)R: Gas Safety (Management) Regulations (1996).

The investment in our flow-weighted average calorific value (FWACV) metering systems at these offtake sites are covered separately (Appendix 09.10 Offtakes & PRS Metering Systems).

We have used an engineering assessment of the reliability and overall system resilience of our odourisation units to inform our investment case. We have then used our AIM model as a check, to enable us to develop an optimum investment case for RIIO-2.

Through good stewardship, our assets are performing well, and we are proposing a small investment programme for RIIO-2 with material work planned for RIIO-3 and beyond.

To prepare for RIIO-3, Cadent intends to deliver two pilot projects during RIIO-2. These pilot projects will proactively replace and trial new odourisation equipment (different designs, makes and models) to explore the optimum solution for the longer term. This will enable Cadent to make the right decisions for customers in RIIO-3, and ensure that it has an optimum solution, for an end-of-life replacement, that is delivered in a planned and cost-effective manner throughout future years.

Investment in this area is low: we propose £XXXXk of expenditure to install two new installations.

3. Equipment Summary

This investment case only covers the odourisation systems located at our NTS offtake sites. There are a total of 50 offtakes sites across our four gas distribution networks. These odourisation systems work in conjunction with our FWACV metering systems. The flow rate recorded by the meter systems enables appropriate levels of stenching agent to be added.

Below is a schematic diagram showing key systems at offtakes with odourisation systems:

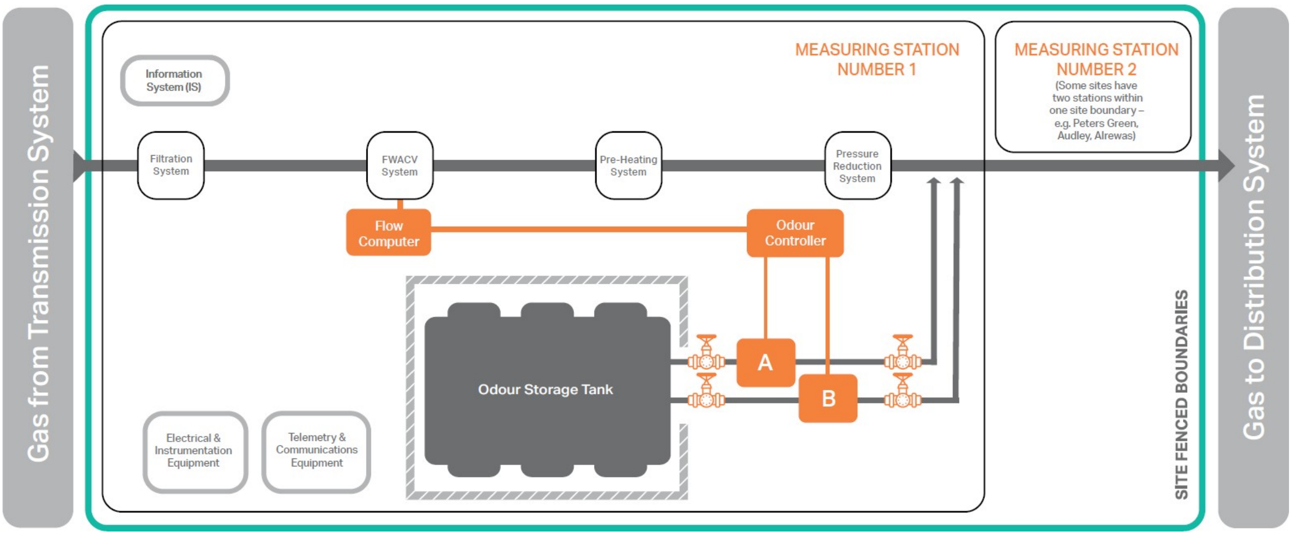

Figure 1: Typical ideal layout of a measuring station showing odourisation equipment

Odorant is added to gas prior to its entry into the distribution network. It is injected into our network via a pumping system at a national offtake. The odorant is stored in a tank surrounded by a concrete bund. The volume of odorant added is linked to the flow of gas.

The odourisation system is contained within a cabinet and has dual redundancy of pumps, controllers and batteries with self-checking features (i.e. if one component fails, the redundancy takes over). As part of interventions undertaken in RIIO-1, the controllers at many sites have been replaced.

Figure 2: Odourisation system cabinet with dual redundancy features

The system is connected to a tank supplying odorant to the nozzle, injecting the odorant into the gas network.

The following table summarises the models of odourisation systems in use within Cadent. One system is on each offtake site. All odourisation systems installed are manufactured by YZ Systems.

Model of odourisation system	Number of odourisation systems				
	EoE	Lon	NW	WM	TOTALS
6200	7	0	1	2	10
7200	11	2	5	8	26
8200	6	1	4	3	14
TOTALS	24	3	10	13	50

Table 1: Odourisation systems asset stock

These differ by the pump size and volume of odourisation they add to the network. There are four tank sizes, ranging from 2,300 litres up to 23,000 litres in capacity, which are configured with the odourisation systems in varying combinations.

The condition of odourisation assets is summarised below. Condition is assessed through visual condition surveys, with clear criteria used to assign an asset to a condition band. Condition 1 assets are in very good condition, typically new or refurbished, with little or no evidence of deterioration. Condition 5 assets are in very poor condition, with the asset in unacceptable condition with widespread evidence of deterioration and imminent failure.

The condition of our odourisation units is shown below. There are two asset units in each odourisation system with one system on a site.

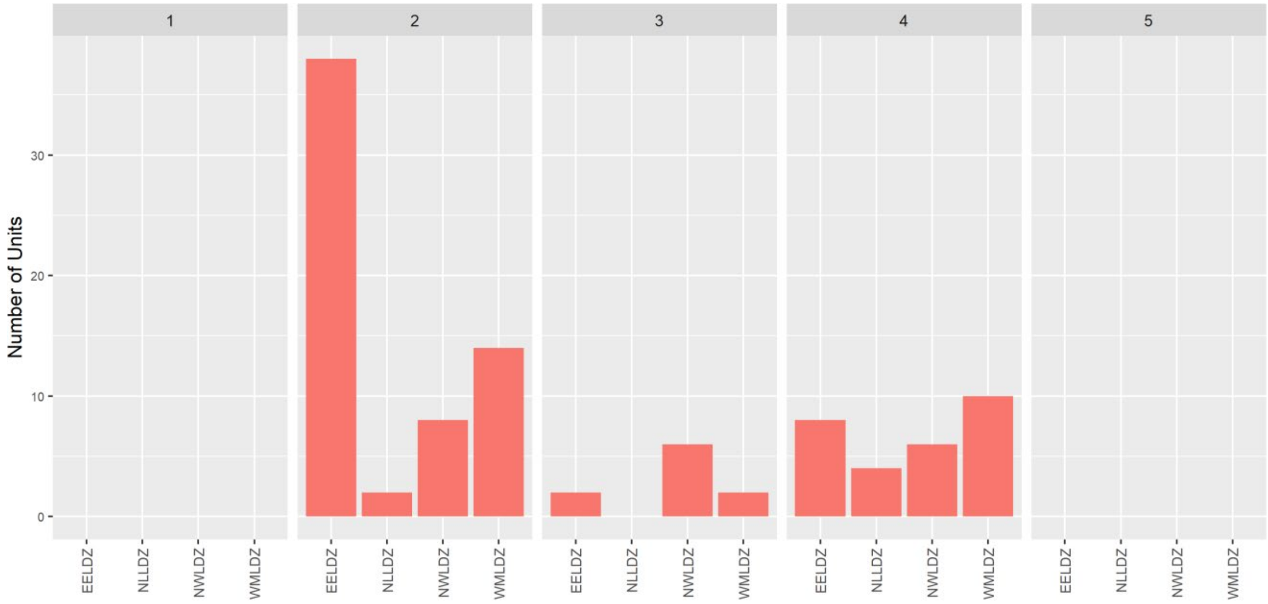

Figure 3: Condition grade of odourisation units in 2019

While these systems are over 20 years old, critical spares are held in bonded stock with a service provider. The systems are undergoing significant overhaul of the control cabinets during RIIO-1, to support operation in RIIO-2.

4. Problem Statement

Overview

Odourisation is part of the safety case and legal requirements. The equipment is safety critical.

We have a duty to maintain a safe network, underpinned by statutory requirements. GS(M)R Gas Safety (Management) Regulations (1996).

IGEM-SR-16 states that:

> *"gas must be treated with a "suitable stenching agent" to ensure it has a "distinctive and characteristic" odour. A characteristic odour is achieved by selection of an appropriate odorant that imparts an odour that is generally recognisable by members of the public as "gassy" and less likely to be confused with other smells such as drains or sewers etc."*

These systems are ageing overall (many are over 20 years old), however, we have undertaken significant overhauls during RIIO-1 to remediate unreliable components.

All odourisation units are manufactured and maintained currently by single source supplier.

Currently the installed odourisation systems are gas actuated, and whilst reliable, release significant gas emissions during operation which has an environmental impact.

Our base case supply demand scenario for this investment case is our peak 1 in 20 year demand to comply with our Licence Obligations. The variability of demand in future forecasts is small; our demand would have to change significantly to require a step-up or down in model-size of odourisation unit required, as such we have only considered one supply demand scenario.

Investment Drivers

The key investment drivers for the provision of odourisation (local gas treatment) are:

- **To ensure the safety of our customers and employees:** The stenching agent added allows gas leaks to be detected, reported and resolved quickly, minimising the risk of fire or explosion as a result of the gas leak.
- **To ensure the security of supply:** While the risk of a catastrophic failure of the odourisation system is very low, because the systems have in-built redundancy and critical spares are available, the risk still remains. However, if the odourisation system did catastrophically fail, this could lead to a major supply interruption, where supply would have limitations placed upon it to restrict the entry of unodoursed gas.
- **To reduce the environmental impact of our dosing equipment through time**

Key Outcomes

The outcome of this investment case is to maintain a safe and reliable gas distribution network, through the provision of gas with appropriate levels of stenching agent, to aid with the early detection of gas leaks.

Understanding Project Success

Project success will maintain a reliable and cost-effective set of odourisation systems at all NTS offtake sites.

4.1. Narrative Real-life Example of Problem

Given the low level of proposed investment, £XXXXm, this section has not been completed as part of our submission. The robust redundancy built into the odourisation systems means there is no real-life example representative of RIIO-2 investment.

4.2. Spend Boundaries

This investment case only includes the odourisation system, including; isolation valves, civil, mechanical, instrumentation, control, and power-supply. The metering system and associated calorific value determination device are included in a separate investment case (09.10).

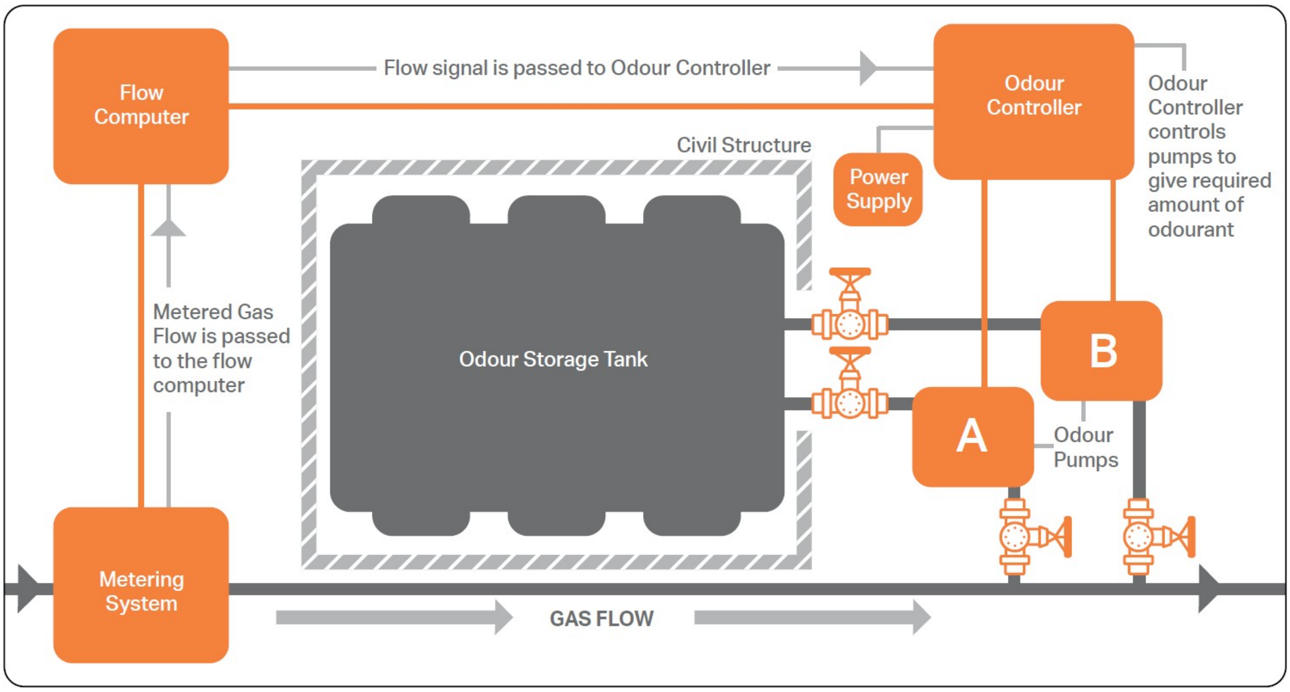

Figure 4: Odourisation investment case spend boundaries

5. Probability of Failure

The NOMs methodology, developed with Ofgem, is an approach that allows us to understand the risk on our assets and the benefit that investment will have. We have followed good practice set out in the NOMs methodology[1] in developing our probability of failure and consequence of failure estimates for odorant assets. This is summarised below and in Section 6.

This section discusses our view of probability from our models and a further view of the probability of failure based on engineering and expert judgement.

Probability of failure within our models

The failure modes for offtake odorant in the NOMs model are:

- **High Odorant**
- **Low Odorant**
- **Release of Odorant**
- **General Failure**

Our assessment of the probability of failure is part of developing our end-to-end analytical framework for these assets, which is shown in the risk map below. The yellow nodes show the failure effects. We do not consider the different asset component failures that could occur to drive these failure effects.

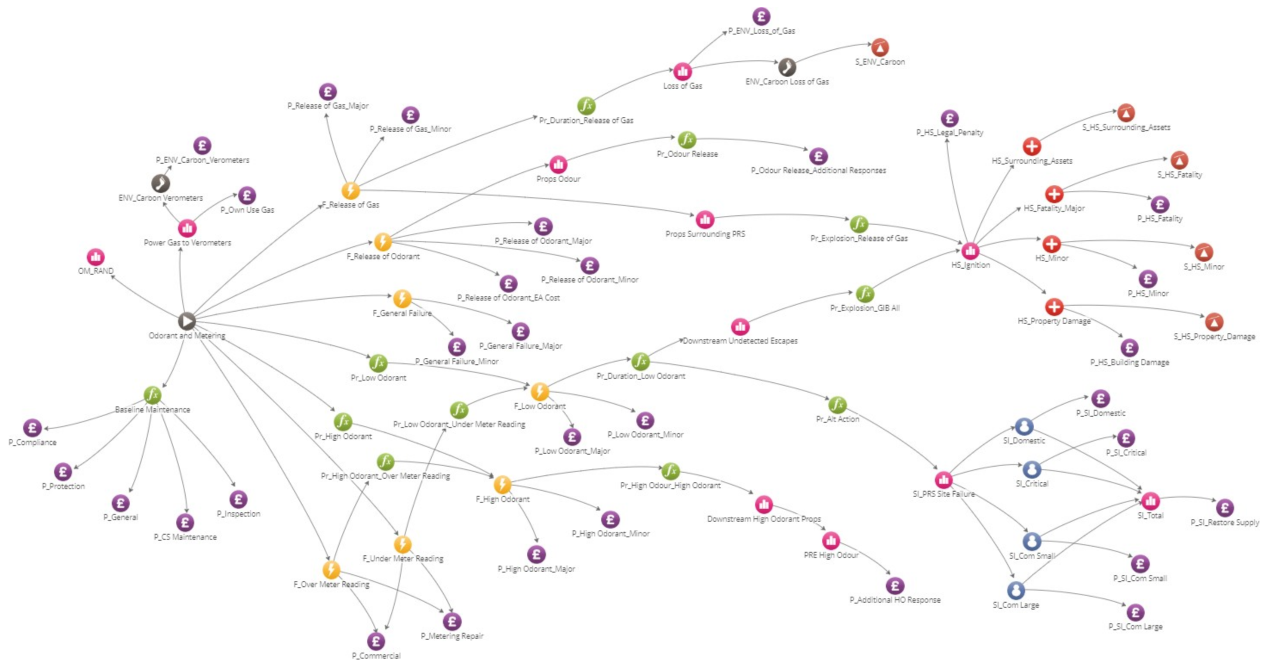

Figure 5: Risk map for Odourisation systems within model

The risk map also shows the consequences of failure, which is explained in the next section. Applying the failure models to our asset base gives the following predictions of failure over time:

[1] NOMS, March 2016, Appendix E

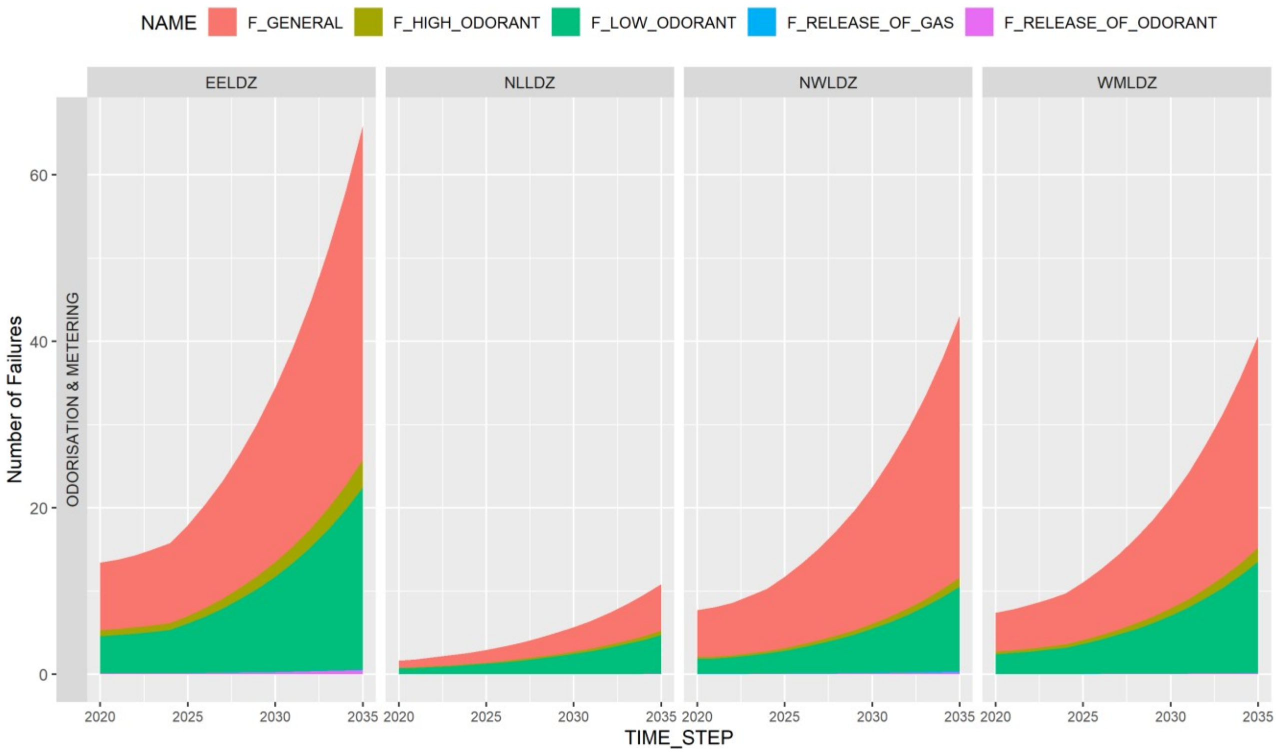

Figure 6: Probability of failure (POF) over time for reactive only (no investment) split by network and coloured by failure mode

The reactive only failures plot, split by failure modes, show an increasing trend with general (coral pink) and low odorant failures (green) to be the largest proportion. From the chart above; it can be seen that within 10 years, the model shows that the probability of failure begins to grow significantly from 2025. East of England has the highest overall failure risk and North London the lowest. The absolute number of failures remains low.

Probability of failure based on expert judgement

In addition to the modelling work using the risk monetisation tool, we have used internal subject matter expert knowledge within an engineering assessment of probability of failure. There have been no known component failures, leading to a total shut-down or failure of local gas treatment within the Cadent networks. We have dual redundancy of all equipment other than bulk storage tanks and injection points.

We have looked at the three years of alarm faults recorded and collated for a review of IGEM standard SR/16: Odorant Systems for Gas Transmission and Distribution (Safety Recommendations).

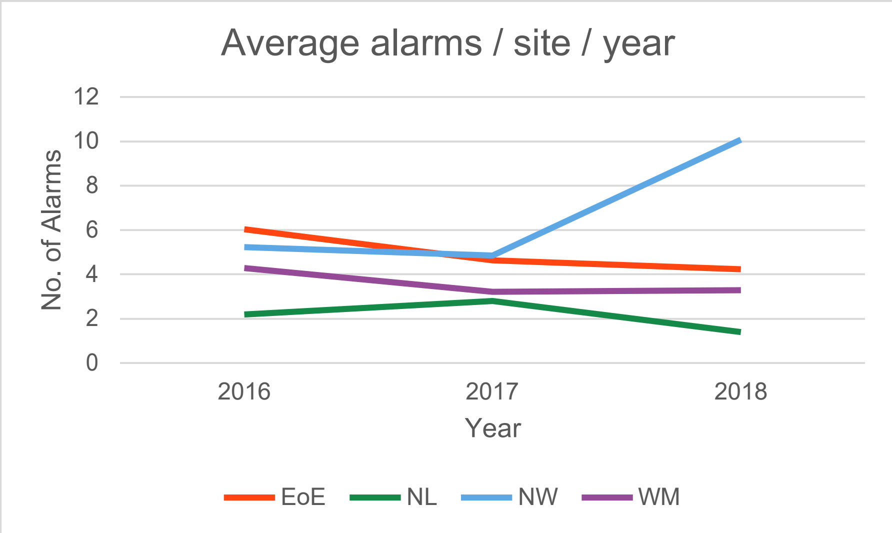

Figure 7: Number of Odourisation alarms per site per year

The trend overall is averaging out at five faults per site per year; with variations observed between networks, sites and years.

The low volume of alarms gives an indication that the assets are generally operating reliably.

Many alarms can be dealt with remotely, without the need for a visit. Persistent alarms may require a service visit. Due to the in-built redundancy within the equipment, single-equipment failures do not have any impact on site operation.

5.1. Probability of Failure Data Assurance

The following key data sources have been used to derive the probability of failure data:

- The number of assets was derived from the CADENT SAP asset database on February 2019
- The fault data was extracted from historic failure rates captured through MDC (Mobile Data Capture) fault forms. The temporal range for this MDC fault data set is 7.6 years (23/05/2011 to 31/12/2018) and contains records relating to mechanical type failures on Offtakes and HP PRS installations.

The current performance assessment of Odourisation systems using alarm faults were sourced from a Control Centre alarms extract collated for a review of IGEM SR/16 in 2019, which is seen as a reputable source of information to support this investment case.

We are confident we have a good understanding of our asset numbers, and we also understand the volume of alarms associated with the odourisation equipment.

6. Consequence of Failure

Linking failures to consequences

Each failure mode and probability of failure has been assessed in terms of its potential consequence. The consequences of failures are:

- **Pre Odour Release** – an increase in publicly reported escapes in the vicinity of the offtake due to odour release
- **Release of Gas** – a loss of gas arising from the odorant asset itself
- **Downstream Undetected Escapes** – undetected gas escapes downstream
- **Pre High Odour** – an increase in public reported escapes downstream of the network due to odour release
- **Ignitions/Explosion** – an explosion, either at the odorant asset itself or in the downstream network

The release of gas results in an increased carbon footprint arising from the emissions. Ignitions present a health and safety hazard, with the potential to cause fatalities and serious injuries (particularly if the gas is odourless and its presence is not obvious). Increases in the odour of gas can cause significant alarm to the public.

Each potential consequence has been expressed as monetary values using the agreed industry methodology enhanced with our own Willingness to Pay (WTP research), as shown below.

Customer Driver	Data source
Environment – GHG emissions	UK Government. Value agreed with Ofgem. - *Increases from XXXX tCO2e in 2021 to XXXX tCO2e in 2071.*
Safety – injuries and deaths	UK Government (HSE). Value agreed with Ofgem. - *Cost per Fatality XXXX* - *Cost per Non-Fatal injury XXXX*
Interruptions to supply – per property	WTP research. Independently assured. - *Range of values computed depending on duration and property type, e.g. XXXX per domestic property for up to 24 hours interruption.*
Other societal impacts	Our analysis includes wider impacts such as property damage and transport disruption. - *Property damage varies according to region, e.g. EoE region £XXXX. Based on average regional property price from HPI report Sept 2015. We apply inflation of 5.5% per annum as per current CBA.* - *Transport disruption varies according to road type and length of impact, e.g. motorway disruption £XXXXk per day based on DfT data.*
Financial impact – cost of repairs (unit)	Company accounts.
Financial impact – cost of replacement (unit)	Company accounts.

Table 2: Sources of societal benefits

These have been estimated using a range of sources, including our own willingness to pay research with our consumers as well as published government values for carbon, risk of fatality, and non-fatal injuries.

We have also included the financial consequences associated with fixing failures as they occur (e.g. repair costs) and remedying the consequences of failures (e.g. clean up and compensation). Our financial impacts are based on a robust assessment of our costs.

All of these consequences can be seen in the risk map presented in Section 5. The pink nodes represent the consumer and environmental impacts; the red nodes are the safety impacts and the purple nodes are the financial consequences.

The chart below shows the percentage contribution of financial risk components:

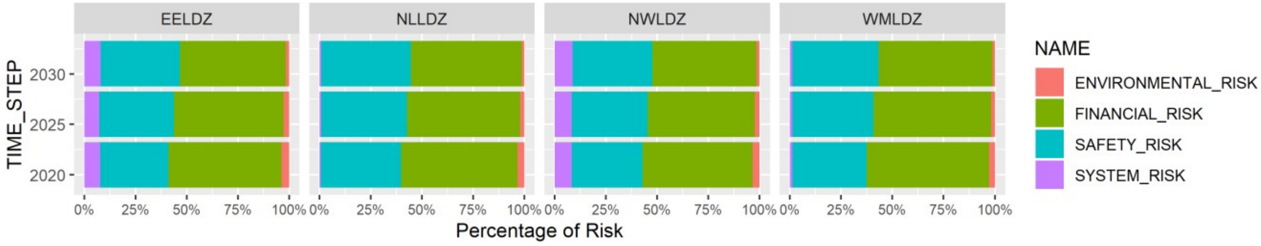

Figure 8: Proportion of risk components over time split by network

This chart shows the proportion of key risk components for each network over time. An increasing proportion of safety risk (blue) can be seen and East of England and North West showing a small proportion of system risk (purple).

7. Options Considered

Introduction and approach

Our objective is to build a plan which best-reflects customer and stakeholder expectations. To achieve this, we have developed a methodology which links asset performance to customer impacts and legislative requirements.

In RIIO-1 we invested in the AIM decision making tool to allow us to build asset management capability using the NOMs approach.

We have used bottom up engineering assessments and our NOMs monetised risk model to develop and appraise investment options for our RIIO-2 plan. A range of options has been considered based on discussions on credible and informative options for these assets.

The comprehensive list of options considered is summarised below; this includes a number of options considered as part of sensitivity testing which are for comparison purposes only:

Option	Description
0	Reactive only
1	**Engineering Volumes Option** Engineering assessment of asset health and trial proposal.
2	**Minimum investment to maintain stable risk (RIIO-2 only)** Used our monetised risk model to assess interventions and capex spend needed to hold risk flat within the model.
3	**Max Whole life Benefits (RIIO-2 only)** Used our monetised risk model to assess interventions whilst maximising whole life net benefit.
4	**Minimum investment to maintain stable risk (RIIO-2 and RIIO-3)** For comparison purposes, we have also considered the inclusion of RIIO-3, to see if the option is still value for money.
5	**Max Whole life Benefits (RIIO-2 and RIIO-3)** For comparison purposes, we have also considered the inclusion of RIIO-3, to see if the option is still value for money.
6	**Chosen option less customer willingness to pay (WTP)** For comparison purposes, we have also considered our preferred option excluding customer willingness to pay for interruptions to see if the option is still value for money without this element considered. *This option has not been described below because it has been used as a sensitivity test for Option 1.*

Table 3: Odourisation options considered

All options are compared to the baseline (Option 0), which involves reactive only investment, and the associated maintenance and repairs.

Our approach to modelling

In RIIO-1 we have invested in the software tool AIM to allow us to build asset management capability using the NOMs approach. AIM includes an optimisation capability which allows us to model different investment scenarios and produce optimised plans and test their cost benefit. The CBA capability within AIM can find the best solution to a problem with many potential solutions (options).

Our model has been applied in RIIO-2 at Odourisation unit level (2 units make up a system) – meaning that individual assets and their performance can be modelled producing precise results for the plan.

Our approach to CBA and options analysis

We have used cost benefit analysis (CBA) to assess the costs and benefits of investment to determine if the benefits outweigh the costs. Our approach to discounting aligns with the Spackman method, which has been embedded within AIM.

For any scenario; we have understood the year on year totex costs, together with monetised risk impacts in a cost benefit analysis. Costs and benefits are discounted and shown in present value (PV) terms in line with Ofgem requirements and HM Treasury Green Book.

7.1 Option 1 – Engineering assessment of asset health and trial proposal (preferred)

During RIIO-1, a targeted programme of component-level replacements has been delivered, and Cadent has purchased a broad range of strategic spares. We will therefore be able to efficiently maintain our current asset stock without any major proactive investments throughout RIIO-2. For this reason, in this option, we are not requesting any proactive capex expenditure to maintain the asset health of this equipment.

We do, however, recognise that by the end of RIIO-2, this equipment will be obsolete: it will be over 25 years old, and strategic spares may be more difficult to source. Our existing odourisation systems also have a carbon footprint as they release gas as part of their operation. We therefore want to take the opportunity during RIIO-2 to assess other odourisation technology to establish a robust and cost-effective strategy for maintaining our odourisation systems during RIIO-3. For this reason, we are proposing to proactively upgrade two sites during RIIO-2, which will inform our asset management approach for RIIO-3.

Our proposed spend profile is to deliver these two proactive upgrades in the East of England (EoE) and North West (NW) regions. This investment has been spread evenly throughout the RIIO-2 period, to inform our RIIO-3 strategy, and is summarised below:

Region	2021/22	2022/23	2023/24	2024/25	2025/26	Total
EoE						
Lon						
NW			Redacted due to commercial sensitivity			
WM						
Total						

Table 4: Proposed spend profile for Option 1

7.2 Option 2 – Minimum investment to maintain stable risk (through modelling) (RIIO-2 only)

We have used our NOMs monetised risk model to assess the investment needed to “hold monetised risk flat”. Constraints are applied so that the total monetised risk is maintained, this allows individual risk categories (e.g. safety, environment, etc) to increase or decrease in delivering stable risk.

The resulting intervention volumes are:

Region	2021/22	2022/23	2023/24	2024/25	2025/26	Total
EoE	1	0	0	1	0	**2**
Lon	1	0	0	0	0	**1**
NW	1	0	0	1	0	**2**
WM	1	1	0	1	0	**3**
Total	**4**	**1**	**0**	**3**	**0**	**8**

Table 5: Intervention volumes: Option 2

The resulting capex spend is (costs in £m):

Region	2021/22	2022/23	2023/24	2024/25	2025/26	Total
EoE						
Lon						
NW						
WM						
Total						

Table 6: Capex costs: Option 2

7.3 Option 3 – Max whole life Benefits (RIIO-2 only)

We have used our NOMs monetised risk model to assess the investment needed to achieve the lowest whole life cost. By default, this maximises the total net benefit for customers.

The resulting intervention volumes are:

Region	2021/22	2022/23	2023/24	2024/25	2025/26	Total
EoE	2	2	2	2	2	**10**
Lon	0	0	0	0	1	**1**
NW	1	1	1	1	1	**5**
WM	1	1	1	1	1	**5**
Total	**4**	**4**	**4**	**4**	**5**	**21**

Table 7: Intervention volumes: Option 3

The resulting capex spend is (costs in £m):

Region	2021/22	2022/23	2023/24	2024/25	2025/26	Total
EoE						
Lon			Redacted due to commercial sensitivity			
NW						
WM						
Total						

Table 8: Capex costs: Option 3

7.4 Option 4 – Minimum investment to maintain stable risk (through modelling) (RIIO-2 & RIIO-3)

For comparison purposes, we have also included an additional scenario as part of our sensitivity testing. This is an extension of Option 2, allowing stable risk to be maintained until the end of RIIO-3.

The resulting intervention volumes are:

Region	2021/22	2022/23	2023/24	2024/25	2025/26	Total
EoE	1	0	0	1	0	**2**
Lon	1	0	0	0	0	**1**
NW	1	0	0	1	0	**2**
WM	1	1	0	1	0	**3**
Total	**4**	**1**	**0**	**3**	**0**	**8**

Table 9: Intervention volumes: Option 4

The resulting capex spend is (costs in £m):

Region	2021/22	2022/23	2023/24	2024/25	2025/26	Total
EoE						
Lon						
NW						
WM						
Total						

Table 10: Capex costs: Option 4

7.5 Option 5 – Max whole life benefits (RIIO-2 & RIIO-3)

For comparison purposes, we have also included an additional scenario as part of our sensitivity testing. This has the same volumes as Option 3 but includes RIIO-3 also.

The resulting intervention volumes are:

Region	2021/22	2022/23	2023/24	2024/25	2025/26	Total
EoE	2	2	2	2	2	**10**
Lon	0	0	0	0	1	**1**
NW	1	1	1	1	1	**5**
WM	1	1	1	1	1	**5**
Total	**4**	**4**	**4**	**4**	**5**	**21**

Table 11: Intervention volumes: Option 5

The resulting capex spend is (costs in £m):

Region	2021/22	2022/23	2023/24	2024/25	2025/26	Total
EoE						
Lon						
NW						
WM						
Total						

Table 12: Capex costs: Option 5

7.6. Options Technical Summary

	Option 0: Reactive	Option 1: Engineering assessment	Option 2: Min investment to maintain stable risk (RIIO-2)	Option 3: Max whole life benefits (RIIO-2)	Option 4: Min investment to maintain stable risk (RIIO-2 & 3)	Option 5: Max whole life benefits (RIIO2 & 3)
Description	Reactive only, fix on failure	Engineering assessment of asset health and trial proposal.	Used our monetised risk model to assess interventions and capex spend needed to hold risk flat within the model.	Used our monetised risk model to assess interventions whilst maximising whole life net benefit.	For comparison purposes, we have also considered the inclusion of RIIO-3, to see if the option is still value for money.	For comparison purposes, we have also considered the inclusion of RIIO-3, to see if the option is still value for money.
First year of spend	2021/22	2021/22	2021/22	2021/22	2021/22	2021/22
Last year of spend	2025/26	2025/26	2025/26	2025/26	2025/26	2025/26
Intervention Volumes	No interventions	2 sites	8 sites	21 sites	8 sites	21 sites
Design life	23 years	23 years	23 years	23 years	23 years	23 years
Total installed cost (RIIO-2)			Redacted due to commercial sensitivity			

Table 13: Technical Summary Table

Option 6 is the same as Option 1 in the table above and has been used to test the sensitivity of the chosen result to the removal of willingness to pay in the CBA results.

7.7. Options Cost Summary Table

The following table compares all options. Costs in £m.

	2021/22	2022/23	2023/24	2024/25	2025/26	Total
Baseline						
Option 1						
Option 2						
Option 3						
Option 4						
Option 5						

Redacted due to commercial sensitivity

Table 14: Option Cost summary table

Our RIIO-2 forecasts, as well as adjusting for workload and work mix factors, also include ongoing efficiencies flowing from our transformation activities and the updating and renewing of our contracting strategies. Our initiatives are outlined in Appendix 09.20 Resolving our benchmark performance gap. For Capex activities this seeks a 2.9% efficiency improvement by 2025/26 on the end of RIIO-1 cost efficiency level. We have applied an efficiency of an average of 0.90% over 5 years. (0.3% in first year raising to 1.50% in 5th year), to this investment area. All costs in this document are post efficiency.

For Offtakes & PRS Odourisation Systems our confidence is defined as being within Conceptual Design stage with a range of +/-20%.

Unit costs of odourisation interventions

The list of unit costs for intervention types used in the model are summarised below:

Option Name	Intervention Type	£k
Option 1: RIIO-2 Odourisation Equipment Upgrade Trial for 2 sites (1 low flow, 1 high flow)	Trial for 2 sites	Redacted due to commercial sensitivity

***Note these total costs are over the RIIO-2 period and have 2018/19 unit costs with efficiencies applied**

Table 15: Costs for odourisation system trials

Option Name	Intervention Type	£k
Option 2: Minimum investment to maintain stable risk	Replace	Redacted due to commercial sensitivity
	Refurbishment	
Option 3: Max Benefits for Customers	Replace	
	Refurbishment	

Table 16: Modelled unit costs for odourisation interventions

Our 2018/19 unit costs are used for the base of our plan. We have developed cost models based on our recent delivery experience in the RIIO-1 period.

8. Business Case Outline and Discussion

We have examined investment need using two approaches. We have modelled deterioration in AIM based on the simplified view of odourisation in our models. We have conducted a detailed review of asset health and failure data to form an engineering view.

Our models predict that faults will increase through time, particularly as we enter RIIO-3. However, because of their critical function our odorant systems have inbuilt resilience which prevent individual faults manifesting as system failures (with a resultant safety impact). As such, we judge that we do not yet need to begin an extensive programme of intervention. Instead we will invest in RIIO-2 to further understand condition and performance in addition to identifying and trialling new odourisation equipment which we can deploy in RIIO-3. In particular, we will work with our supply chain to identify means of reducing the emissions associated with our odourisation equipment.

8.1. Key Business Case Drivers Description

Our objective is to build a plan which best reflects customer and stakeholder expectations and meets the required outcomes for this investment. To achieve this, we have developed a methodology which links asset performance to customer impacts, making use of models to evaluate options using CBA.

Our drivers for this investment case are to ensure all our assets remain operating safely, efficiently and reliably to maintain:

- Compliance with health and safety and environmental regulations
- Security of supply to customers
- Value for money; efficiently intervening in our assets. This involves trialling new methods to ensure we reduce customers' bills.

8.2. Business Case Summary

The results of the analysis over RIIO-2 are shown in the tables below. For any scenario, we have understood the year-on-year totex costs, together with monetised risk impacts in a CBA.

The table shows the present value of costs for each option to 2050. Costs and benefits are discounted and shown in present value (PV) terms in line with Ofgem requirements and HM Treasury Green Book.

The table shows the present value of costs for each option. This shows 5 years of investment over RIIO-2, unless stated otherwise (given the requirements for RIIO-3 will not be specified until after the RIIO-2 pilots are complete).

Option No.	Option Description	PV Expenditure & Costs (£m)	PV Environment (£m)	PV Safety (£m)	PV Reliability (£m)	PV Other (£m)	Total PV (£m)	NPV (relative to baseline) (£m)
0	Reactive Only							
1	Engineering Volumes Option (Chosen)							
2	Minimum investment to maintain stable risk							
3	Max whole life Benefits							
4	Min investment to maintain stable risk (RIIO-2 and RIIO-3)							
5	Max whole life Benefits (RIIO-2 and RIIO-3)							
6	Engineering Volumes Option exc. WTP							

Redacted due to commercial sensitivity

Table 17: Present value of costs and benefits for the modelled scenarios

The following text provides a guide on how to read and interpret the results in the above table

- NPV for each option is computed as the difference between the total PV for the option and the total PV for the baseline.
- PV expenditure and costs shows discounted sum of proactive investment (replacement or refurbishment costs), maintenance, repairs and other ongoing opex costs. Proactive investment has been considered over RIIO-2, although we have included some scenarios that consider 10 years of investment: RIIO-2 and RIIO-3. All other financial costs are considered over the full period to 2050. All financial costs are discounted using the Spackman approach.
- PV environment shows the discounted sum of leakage and shrinkage, using the base case cost of carbon.
- PV safety shows the discounted sum of the risk of fatalities and injuries, as valued using the Ofgem stated costs per Fatality and cost per non-fatal injury.
- PV reliability shows the discounted sum of interruption risk, as valued using our own valuation research (e.g. the willingness to pay study into the cost of interruptions to homes and businesses).
- PV other shows the discounted sum of any other impacts, as valued using our research into the cost of property damage and transport disruption.
- Costs are presented as negative values. The total PV is the summation of the five categories of costs.
- The baseline has been specified as the minimum investment position. The NPV for each option is computed as the difference between the total PV for each option and the total PV for the baseline. A positive NPV means an option has less costs associated with it relative to the baseline and is therefore cost beneficial. The option with the highest positive NPV is the most cost beneficial of the options considered.
- The options deliver benefits across the monetised risk categories: safety, environment, financial, and customer interruptions.

The table below summarises the cost benefit results for each option. This provides the NPV for the option (computed as the difference in total PV relative to the baseline) – to show which options are cost beneficial or not. We also include the payback period, the RIIO-2 (replacement and refurbishment only), and the ratio of NPV to RIIO-2 to understand how much NPV per £ spent in RIIO-2 the options generate.

Option No.	Option Description	NPV - Relative to baseline (£m)	Cost beneficial	Payback Year	RIIO-2 spend (Replace, Refurb) (£m)	Ratio NPV to RIIO-2 replace/refurb spend
0	Reactive Only		N/A	N/A		N/A
1	Engineering Volumes Option (Chosen)		Cost beneficial	2025		125.02
2	Minimum investment to maintain stable risk (RIIO-2 only)		Cost beneficial	2022		532.29
3	Max whole life Benefits (RIIO-2 only)		Cost beneficial	2024	Redacted due to commercial sensitivity	202.51
4	Minimum investment to maintain stable risk (RIIO-2 and RIIO-3)		Cost beneficial	2022		830.94
5	Max whole life Benefits (RIIO-2 and RIIO-3)		Cost beneficial	2024		209.47
6	Engineering Volumes Option exc. WTP		Cost beneficial	2025		123.58

Table 18: CBA analysis for the modelled scenarios

The following text provides a guide on how to read and interpret the results in the above table

- The NPV for each option is computed as the difference between the total PV for each option and the total PV for the baseline. A positive NPV means an option has less costs associated with it relative to the baseline and is therefore cost beneficial. The option with the highest positive NPV is the most cost beneficial of the options considered.
- Payback shows the year when the sum of costs associated with an option is lower than that of the baseline i.e. this is the point at which the option can be considered to be cost beneficial. This is driven by the profile of the costs and the capitalisation rate.
- The table shows the RIIO-2 proactive expenditure. If applicable the RIIO-3 proactive expenditure is also shown.
- The ratio of NPV to RIIO-2 spend shows how much NPV per £ spent in RIIO-2 the options generate. A positive figure means the investment is cost beneficial. The higher the figure the most cost beneficial the option is.
- We have also provided the ratio of NPV to the combined RIIO-2 and RIIO-3 spend for those options where 10 years of proactive expenditure has been considered.
- In assessing these CBA results, we recognise we need to balance NPV, payback, and the ratio of NPV to proactive spend, alongside other considerations.

Also, it should be noted that there are high modelled financial benefits in this investment case and further discussion is provided in Appendix 1.

Option discussion

The tables above shows that all investment options are highly cost beneficial. This shows the importance of these assets in delivering for our customers.

Option 1 is the preferred option for our RIIO-2 investment case. This allows us to meet our obligations in RIIO-2 whilst allowing us to develop our strategy for maintaining our odourisation systems cost effectively from RIIO-3 onwards. It delivers safety and financial benefits, which make the investment very cost beneficial.

It is worth noting that the large NPV for this option is largely driven by the choice of sites for the pilot. There are two pilot sites: Blackrod in the North West and Walesby in the EoE. Blackrod supplies 740,000 customers which means that any issues at this site can have very large impacts on customers, meaning that our proposed investment – whilst modest in nature – provides significant benefits for our customers. In contrast, Walesby supplies a more modest 4,500 customers, but it is also very cost beneficial to invest in this site.

The most cost beneficial option is Option 3. This has a much higher NPV than our preferred option. However, this option is associated with more investment after RIIO-2 as well as in RIIO-2 itself. Our plans actually align well with this scenario – both this and the chosen option are associated with modest spend in RIIO-2, and continuing investment thereafter. Option 5 shows the impact of continuing to maximise whole life benefits into RIIO-3. This confirms that modest investment is needed in RIIO-3 to maximise whole life benefits, but this is notable higher than the proposed current investment.

Option 2, to maintain the current level of risk, also has a similar modest level of expenditure, albeit higher than the current proposed plan. Option 4 shows that a similar expenditure figure is needed again in RIIO-3 to continue to maintain stable risk. Given we are spending less than what Option 2 says is needed to maintain stable risk, we expect very small deteriorations in our risk position over RIIO-2.

Option 6 shows that the benefits of this investment remain high, even if the WTP for interruptions is not considered. Interruptions risk has little impact on the CBA results: reducing financial and safety risk are the key benefits of our proposed investment.

Based on the above modelled results, we have compared and contrasted each option in more detail in the following table. This excludes the options 4-6 considered as part of sensitivity testing, which are for comparison purposes.

Option	Pros and Cons
1	Pros – This gives Cadent an opportunity to investigate new odourisation options in a pro-active way, to assist in planning for future replacements of current aged, environmentally polluting equipment before becoming completely life expired, requiring urgent replacement at higher cost. It allows Cadent to manage risks and meet its obligations whilst exploring future options that will allow us to ensure customers' bills are efficient in the future. Cons – This option is associated with a slight deterioration in monetised risk across RIIO-2. We are deferring valuable investment that would be beneficial to invest now. It is being deferred due to the need to wait for the trial results and the future strategy being defined.
2	Pros – Maintains stable risk for our customers, without considerably more expenditure. The investment levels proposed are modest and align well with the chosen option. Cons – Does not provide the opportunity to review our forward looking strategy. May artificially shorten optimum asset life.
3	Pros – Provides maximum benefit for our customers, at a modest cost in RIIO-2 Cons – Associated with a considerable amount of investment in RIIO-3, and does not provide the opportunity to review our forward looking strategy

Table 19: Discussion of the Pro's & Con's for each scenario

Option 1 is the preferred option for this investment. It delivers affordable and value for money for our customers, whilst providing the opportunity to review and reformulate our strategy for these important assets. We believe this reflects the right balance between maintaining our assets and developing the right asset strategies for the future

We are proposing investment at two sites:

1. 1 low flow site, for example, EoE site: Walesby – £XXXXk

2. 1 high flow site, for example, NW site: Blackrod – £XXXXk

The CBA results by region, show below, show that each region is also cost beneficial.

Region	NPV (£m)	Cost Beneficial	Payback	RIIO-2 spend (£m)
EoE	Redacted due to commercial sensitivity	Cost Beneficial	2042	Redacted due to commercial sensitivity
Lon		N/A	N/A – No RIIO-2 spend	
NW		Cost Beneficial	2025	
WM		N/A	N/A – No RIIO-2 spend	
Total		**Cost Beneficial**	**2025**	

Table 20: CBA results by region

The results show that the investment in Blackrod is particularly cost beneficial, given the number of customers this site serves. See the appendix for more details on this site.

Benefits from the investment

The improvements in performance as a result of the chosen investment Option 1 is provided below. The benefits are small given that we are only intervening on 4% of the asset base.

This is also shown in the following chart:

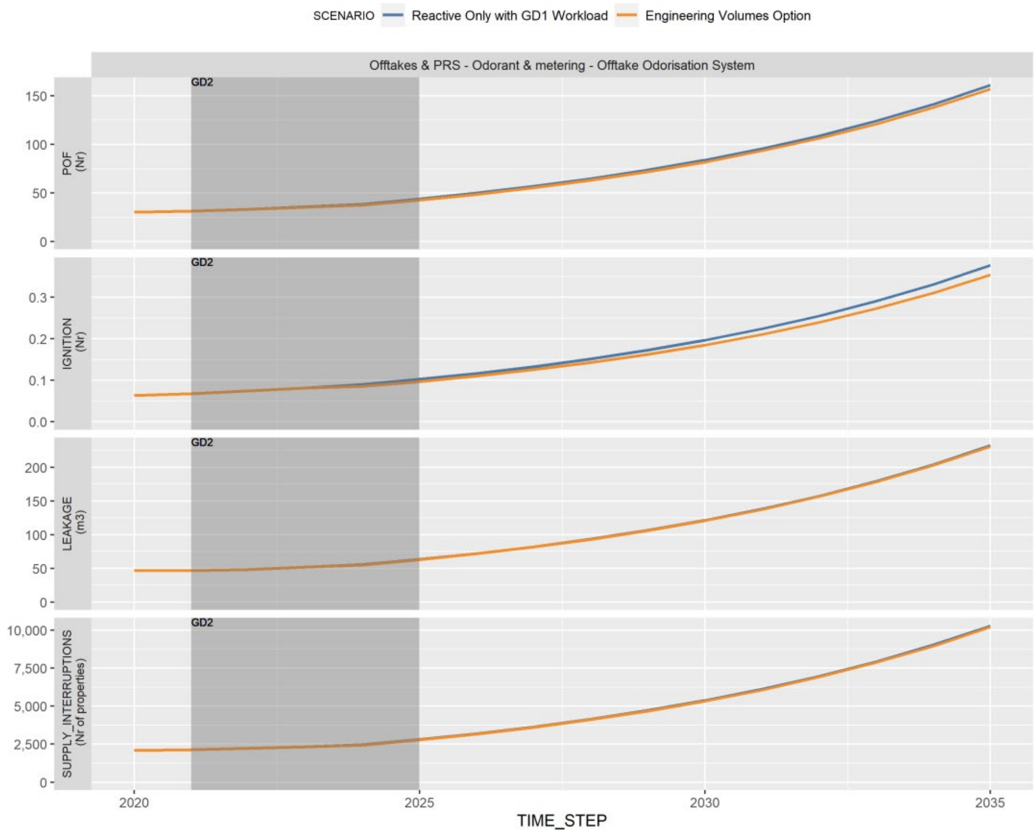

Figure 9: Summary of Baseline vs. Preferred Option 1

This chart shows a comparison of reactive only (no investment) compared directly to the chosen scenario for four key asset health and performance measures. The chosen scenario shows a near identical position to the reactive only position. This is due to only 2 sites out of 50 are intervened upon in RIIO-2 and therefore the benefits from the investment are minimal to the reactive only baseline option. However, the future investment in RIIO-3, will ensure that by 2035 there will be greater improvement, trending further away from the reactive only (no investment) baseline.

9. Preferred Option Scope and Project Plan

9.1. Preferred Option

Our preferred option is Option 1, which ensures we continue to operate the network in a safe, reliable manner, in RIIO-2 with robust effective equipment, whilst trialling new equipment with lower environmental footprints, in preparation for wide-scale implementation in RIIO-3.

9.2. Asset Spend Profile

The following table shows investment spend profile for the trial of the two odourisation systems in RIIO-2:

Region	2021/22	2022/23	2023/24	2024/25	2025/26	Total
EoE						
Lon						
NW			Redacted due to commercial sensitivity			
WM						
Total						

Table 21: RIIO-2 costs for odourisation system trials

9.3. Investment Risk Discussion

This is a small investment programme with low risks.

Reference	Risk Description	Impact	Likelihood	Mitigation / Control
09.11.01	Supply & Demand deliverability risk of Resource availability within the Gas industry	Potential cost increases in labour / commodity markets as demand is greater than supply	Low	Intelligent procurement and market testing. Apprenticeship and Training programmes to fill skills gaps
09.11.02	Stretching efficacy targets may not be deliverable (unit costs increase)	Outturn costs are not met increasing overall programme costs.	Low	Established market place - ability to manage the known commodity market
09.11.03	Unforeseen outages and failures restrict access for planned work	Programme and delivery slippage due to delay of planned outages and or site access	Low	Proactive asset management with ongoing condition surveys and response plans to prevent failures

Reference	Risk Description	Impact	Likelihood	Mitigation / Control
09.11.04	Unseasonal weather in 'shoulder months', Autumn and Spring reduce site access/outage windows	Increased demands affecting access to sites and planned outages delay and cost increases	Low	Controlled forecasting and maintenance of flexibility to react to unforeseen events. Detailed design solutions to minimise outages and reduce exposure.
09.11.05	Unexpected / uncommunicated obsolescence during RIIO-2 period of equipment components	Inability to maintain equipment at full capacity with risk of impact upon supply	Low	Maintain a close relationship with equipment supply chain and manage a proactive early warning system where spares / replacements become at risk.
09.11.06	Legislative change - There is a risk that legislative change will impact the delivery of our work.	Potential increase in the amount of consultation and information exchange required and require us to align our plans with the safety management processes operated by 3rd Party landowner / asset owners. The potential impact is more engagement and slower delivery	Med	We have established management teams to address these issues. We have also identified UMs for key areas.

Table 22: Risk Register

9.4. Regulatory Treatment

This investment will be tracked through the NARMs methodology, the benefits are recorded in our submitted NARMs tables.

This investment is accounted for in the Business Plan Data Table 3.01 LTS, Storage & Entry, within the PRS Sub table under Local Gas Treatment.

Appendix 1. CBA high modelled financial benefits

There are very high modelled financial benefits associated with North West site.

- Blackrod Offtake feeds 750,000 customers but has redundancy available. In the model, when the odour system fails there is a very low probability of interrupting customers when the site is shut down for repairs as backups are available. However, the high or low odorant event still has a probability of not being detected immediately and therefore causing issues downstream before the site is shut down. The large number of customers on the site means these downstream issues have huge consequences, in the case of low odorant large health and safety risk and in the case of high odorant a cost for the First Call Operative (FCO) to visit each of the households affected (£XXXX per household (£XXXXB per event, event probability is extremely low initially)).

The end results are:

- Low system risk due to redundancy
- High health and safety risk due to a large number of households affected before the site is taken offline for low odour events
- Very high financial risk arising from the cost to visit every household in the case of a high odour event (the reduction in this cost alone is greater than the cost of replacing the odorant system on the site within the first year)

For the EoE site, Walesby PRS only feeds 4,500 customers but no redundancy is available. Which results in:

- High system risk as customers will be interrupted is the site is shut down
- Lower health and safety as less customers are affected
- Low financial risk, again, due to a small number of customers are affected