Cadent
Your Gas Network

Appendix 09.00

Overview: How we have developed our investment plan

1. Executive Summary

This appendix sets out the methodology we have followed to develop our investment plan.

Our customers expect a safe and reliable gas network and place trust in us to deliver this in the most cost-effective manner.

Our investment plan has been developed in line with customers' requirements and stakeholder feedback. We have engaged with our customers and stakeholders, using their views and feedback to develop and refine the plan to reflect their preferences around service, affordability and value for money, whilst ensuring full compliance with our legislative obligations.

The development of the investment plan for RIIO-2 is an extension of our business-as-usual planning processes. This has been developed using asset management principles and techniques that align with good practice across the utility sector. Cadent is ISO 55000 certified and our team are Institute of Asset Management (IAM) trained.

Our approach is focused on understanding and responding to customer insights using planning tools which allow us to build the right totex solutions around customer preferences for a safe, reliable and affordable service.

We have ensured that legislative requirements are discharged, and customer expectations are met. 85% of our gross investment plan is underpinned by legislative drivers.

Wherever practical, we have used cost benefit analyses (CBA) to assess the levels of investment and risk improvements in the investment plan. We have undertaken a significant programme to embed CBA into our processes and systems over the last two years, ensuring that it aligns with best practice and meets Ofgem requirements.

A key part of CBA involves modelling and appraising different future scenarios to understand the risk of asset stranding, the lowest whole life cost solutions, the spend/benefit ratio and options with shorter paybacks. We use efficient unit costs, and the benefit values assigned in the NOMs approach and well as from our own customer research to develop our CBA-based plans.

Our consistent and systemised CBA processes cover around 69% of the net investment plan. We apply CBA where there is discretion and choice over the level of investment in our plans. Even where we have safety driven/mandated investment we use CBA to challenge our plans, such as challenging whether we can deliver the outcomes for less, and testing the timing of investment (i.e., can we defer or delay). We question whether the payback of the assets is reasonable and minimises the risk of asset stranding.

Our final investment plan is the culmination of our planning processes, which has taken account of customer views, efficient unit cost assessment, and a robust process of reviewing and testing our proposed plans with stakeholders and our Board.

We are confident that the plan we have developed discharges our legislative duties, improves performance, reduces costs and delivers positive outcomes for customers and stakeholders.

In this appendix we describe our overarching approach to asset management and investment planning. We set out the principles and practices which underpin all our business cases and provides the context within which individual investment decisions have been developed to best meet customer needs. It describes the general principles of how the investment plan has been built, balancing affordability with safety and reliability.

The application of these principles to specific asset types is included in separate Engineering Justification Packs (EJP) and Enhanced EJPs.

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2. Introduction

Our customers expect a safe and reliable gas network and place trust in us to deliver this for them in the most cost-effective manner.

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This appendix describes our overarching approach to asset management and investment planning. It sets out, the principles and practices which underpin all our business cases and provides the context within which individual investment decisions have been developed to best meet customer needs. It describes the general principles of how the investment plan has been built, through application of our asset management policy (Appendix 1), balancing affordability with safety and reliability. This approach generates our RIIO-2 asset strategy.

Details of how these principles have been applied to individual investment decisions are provided in supporting Engineering Justification Packs. These outline the scope, costs and benefits for major projects or aggregated investment programmes. The packs provide quantitative and qualitative assessments of the proposed investments and provide an insight into the investment decision-making processes.

In addition to submitting the standard CBA template and Engineering Justification Pack (EJP) required by Ofgem, we have also submitted more comprehensive investment decision documents ('Enhanced EJPs') for Repex - Multi Occupancy Buildings (MOBs) and Mains and associated Services. These elements are the most material areas of our plan; they have a significant impact on customer service and bills. The hierarchy of submitted documents is shown below:

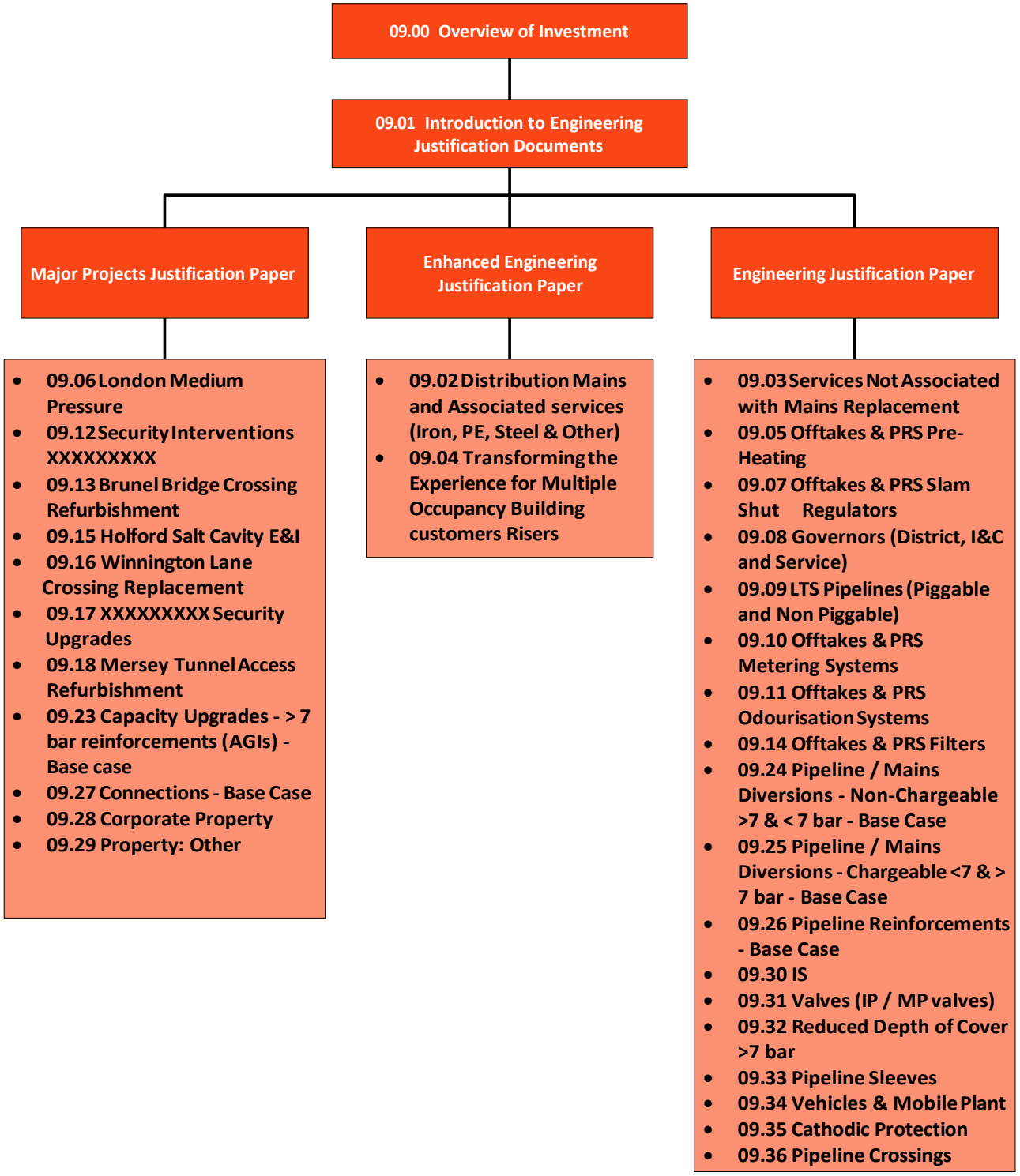


Figure 1: Document Hierarchy – Investment Cases

The RIIO-2 investment team is accountable for developing a plan which meets our legislative requirements, is acceptable to our stakeholders and delivers a standard that our customers love. Our approach follows five steps, shown in the diagram below, to move from a clear articulation of customer and stakeholder needs through options development and analysis to develop performance commitments that our customers love and fair regulatory treatment. These steps are repeated for each area of investment.

- Understand issue: asset condition and performance
- Establish customers' views
- Identify safety or other legislative mandate

- Innovation
- Short/long term options
- Customer impact

- Develop costs
- Costs v benefits (CBA)
- Delivery check

- Ambition
- Stakeholders testing

- Regulatory treatment of investment
- Performance reporting

Figure 2: Plan Development Stages

Establish customer need:

- Identify changes in the external environment including evolving demand profiles, changing attitudes to risk and increasing service expectations
- Understand the condition of our assets and identify problems/issues/opportunities around performance and safety
- Quantify and analyse these items to best understand drivers for change and customer/stakeholder expectations
- Clearly articulate legislative requirements relating to the issue

Develop options:

- Understand current work practices and costs
- Work with business experts to develop new options, including taking no actions, operational interventions, capital expenditure and opportunities for innovation or new ways of working (including 'non-gas solutions')
- Brining in new ideas from outside our organisation, external expertise, new technologies and different ways of thinking

Analyse options:

- Cost development drawing on past experience with adjustments for efficiency and innovation
- Options appraisal using a range of techniques including cost-benefit analysis (CBA) to identify the best solution under different future scenarios
- Review with internal stakeholders, including those accountable for delivery. For an option to be viable it must be deliverable, and the duration of delivery must be taken into account with regards to the time taken to realise benefits.
- Implement independent audit and assurance of our approach that highlights any risks in our methodology

Set standards customers love:

- Continually review to ensure that the solution developed meets the customer needs identified at the start of the process. During summer 2019 we undertook business options testing to refine and validate our initial work.
- Having built separate investment cases, there is a necessary phase of portfolio management: reviewing overlaps and synergies to refine the scope of plans that can work better together or produce a greater effect for less work. There is also a need to see how the different elements of performance sit together in terms of a balanced customer offer.
- Carry out acceptability testing of our proposed overall plan with our customers to ensure we have correctly responded to their needs
- [NB engagement with customers will continue beyond the submission of our business plan, through period we will continue to track customer expectations of service and also engage with local stakeholders regarding how we deliver work in their communities]

Ensure fair regulatory treatment:

- Having established the right solution, consider how best this approach can be funded and measured fairly and transparently within the regulatory framework

This approach is built on best practice, with documented methodologies for each investment area.

This approach delivers against our overarching asset policy ensuring that our asset base meets the needs of our customers. It creates the asset strategy for each asset group which we will deploy in RIIO-2. The process may lead to an evolution of the strategy we deployed in RIIO-1 i.e. we are not entering our planning process with a fixed strategy for a particular asset group but rather applying good asset management practice to develop the correct future strategy.

We are confident that the plan we have developed discharges our legislative duties, improves performance, reduces costs and delivers positive outcomes for customers and stakeholders.

The appendix is structured around seven sections:

1. Asset management best practice
2. Discharging our legislative requirements
3. Costing assurance
4. Customers preferences and willingness to pay
5. Cost-benefit analysis
6. Asset health, criticality and replacement priorities
7. Assurance and challenge

It does not cover our customer engagement which can be found in specific EJPs or in our overarching customer engagement chapter (Chapter 5 in our main plan).

3. Asset Management Best Practice at Cadent

Our approach builds on embedded good practice in asset management. Cadent is ISO 55000 certified and our team are Institute of Asset Management (IAM) trained - to Diploma standard. Our approach is customer, not asset, focused and delivers the correct level of sophistication for an asset base which has low complexity but high levels of safety mandated work. This section outlines our approach to asset management and how it has been applied in the development of our business plan.

Our asset planning processes and tools are used continually to plan and prioritise investment and act to address emerging issues. This section outlines our business-as-usual approach to asset management and investment planning. The process is illustrated in action in the (Enhanced) Engineering Justification Packs (EJPs) which sit alongside this document. Detailed asset-specific investment methodologies have also been produced for internal use, tracking data extraction, processing and expert review.

During RIIO-1, our asset management capabilities have improved considerably and have reached a good standard. The tools we use include risk-based prioritisation, based on investment pounds (£) to consequence to service ratios, and statistical models forecasting future risk and deterioration over the long term. We have invested to automate the Risk Monetisation (RM) reporting process and have embedded optimisation software to allow detailed scenario analysis through an RM or Network Asset Risk Model (NARMs) lens. We employ people trained using the Competency Framework of the Institute of Asset Management (IAM) and are proactive contributors to the gas industry asset management networks. Our asset management policy detailed in Appendix 1 recognises that the health of our physical assets is a critical factor in achieving our customer outcomes. In 2017, we successfully built on our PAS55 certification to achieve accreditation to the asset management standard ISO 55000. We have invested to improve the quality of our asset data, completing physical surveys of our pressure-reduction systems, crossings and electrical and instrumentation equipment: ensuring condition data is current. We have also used advanced data mining and processing techniques to search for and fill gaps in our asset data. These improvements allow us to make better investment choices for our customers.

Using these capabilities, tools and processes, we continually update our investment plan to deliver our outcomes and meet our performance targets. Our commitment to deliver a service our customers love is important because it is a key driver of totex and contributes to determining the bills that our customers will pay. We are, therefore, developing an explicit and detailed costed plan. This provides a clear benchmark against which we can measure our performance during RIIO-2.

Expenditure is based on evidence of the need to address a risk of failure or the need to improve customer service. Deciding when and how to intervene is essential. We aim to tune expenditure so that it is made neither too early nor too late. We are building the investment plan on an understanding of current and future risk and the most efficient solutions.

Service-asset issues and needs are captured on an ongoing basis in a corporate ‘issues log’. Issues and needs (problem statements) may come from asset failure in the routine operation of our assets, ongoing deterioration, process performance issues, from the implementation of a policy or through a third-party trigger such as HSE enforcement. We have workflow systems that allow issues to progress to solutions from identification to delivery and financial completion. This is standard good practice and provides a firm basis for investment planning.

An ‘issue’ (or problem statement) is defined as a system shortfall or opportunity, either actual or predicted, requiring a resolution through:

- Capital investment
- Operational maintenance
- Change in operational practice

It is essential that the initial issue is reviewed detail and in the context of others in the system to get a complete understanding. Several issues may arise from a common cause; several operators may have raised the same

issue or future issues may affect the area (e.g. predicted growth). Therefore, grouping and reviewing the issues is essential to understanding the cause.

Not all issues and problem statements require immediate investment; for some, monitoring and mitigation are sufficient for the short term. To understand what is required, it is necessary to understand it in detail along with its associated service/performance risk. This understanding is developed through engagement between investment planners and operational staff.

Investment planners build strong relationships with the operational teams in their investment areas to understand issues, communicate the progress of issues and update changes in risk that may have occurred.

To increase the detailed understanding of deterioration for most of our investment areas, we use risk models based on the NARMs reporting methodology. These areas (asset types) are pipes (LTS, mains, services and risers) and pressure control installations (governors and offtakes). The models forecast deterioration over the long term, typically 25 years. These models have been developed in partnership with the other GDNs, supported by external consultancies, and with input from Ofgem. Extensive testing and validation have been completed as part of the review and acceptance process with Ofgem. Building on the agreed reporting foundation, we have tuned our models to our asset performance and expanded the way in which the models can be used.

Some models are statistical models of life distribution (e.g. at their simplest a ‘bath tube curve’) that are built using records of maintenance data from our corporate work planning database, SAP. Life-distribution models indicate failure numbers; statistical simulations use the life-distribution data to calculate the number of failures for a type of equipment over time. The granularity of analysis varies between models as described in the EJPs.

For example, the ‘pipes’ models use asset data from our geographical information system (GIS), ESRI, and records of modes of failure such as mains repair, interruptions, and leakage to forecast deterioration by diameter and material. The model represents a failure mode effect analysis (FMEA) considering the likelihood and consequence of different failure mechanisms. We are therefore modelling a ‘web of risk’ rather than a simple – single – failure probability and consequence.

The asset data is refreshed regularly to reflect changes from ongoing activity on our assets.

The models are used to simulate the impact of deterioration on service performance (for example interruptions), but ultimately as a total monetised risk. They are also used to understand the levels of deterioration that could occur and would need to be addressed in order to meet customers’ preferences in service levels.

This approach allows us to identify long-term trends in performance that may not be picked up during day-to-day operation and agree the approach to progressing the issue.

We have regular, formal Asset health meetings every 4-8 weeks, which brings together all parties with an interest in an issue on a specific asset or process to collectively discuss and agree the need and possible options. This includes operations, maintenance, technical strategy and asset management. Meetings are chaired by the Asset Engineer who will bring the relevant data and analysis to support an understanding of the root cause of an issue. They will discuss options to resolve the issue and identify opportunities for innovation or pilot work.

Optioneering is fundamental to the planning process. Using the expertise of the stakeholders, each potential solution is discussed in detail and documented as viable or non-viable. Options could include asset refurbishment, asset replacement, new technology and system reconfiguration. Solutions are always considered from a system perspective. Capex and opex solutions are discussed, and the most appropriate whole-life cost solutions are selected. The submitted EJPs demonstrate the development and testing of options.

When options have been identified, we quantify the risk to service (using risk monetisation where available).

For areas where the model has not been used to develop a delivery volume these have been developed in similar ways to cost build ups discussed within section 4 of this document. This will essentially be a bottom up or a top down approach, this includes use of averaging based on historic data.

The bottom up approach will use actual asset data combined with dynamic asset data to build a profile of volume per network per annum for delivery. The dynamic data includes items such as inspection pass/fail data, replacement policy frequencies and subject matter expert performance tracking data. All of these elements are used singularly or in combination to build investment volumes.

The top down approach is employed where granular data does not exist and may take a view of the number delivered in each previous year forecasted forward on a moving average basis.

3.1. Probability and Consequence of Failure

A risk value is calculated by multiplying the probability of a particular failure by the consequence of failure to the service, which is expressed in monetised form (£). The probability of failure is determined using the failure records held in our corporate system, serviceability monitoring data and operational site data.

All consequence values are monetised (see section 6 below for CBA examples). In limited circumstances, a single failure-type likelihood and consequence is considered but, for most issues, the analysis is more sophisticated, considering the probability of various failure types (i.e. failure modes), the probability that each failure type will lead to a certain consequence, and an assessment of that consequence. This is a monetary-based Failure Mode Effect Analysis (FMEA) approach.

For example, we can assess the probability of a pipe failing by fracture, a second probability assessment must then be made for a specific consequence being triggered:

- A fracture will have a 100% chance of releasing gas (a negative greenhouse gas and commercial consequence both of which can be valued).
- The chance that the fracture will cause an interruption is <100% but a value can be placed on any interruption that does occur.
- The chance of gas getting into a building (a GIB) can also be estimated as can the likelihood that the gas will be ignited, causing an explosion (damage to life and property can be valued).

A pipe may also fail through joint failure or corrosion pinholing. The probability of these failure types and the chance that they will lead to interruptions or explosions can similarly be quantified.

In our computerised modelling the FMEA is represented in a (NOMs) risk map, such as that below.

Risk maps link cause and effect in a graphical and intuitive framework and are conceptually similar to reliability engineering Fault Tree Analysis (FTA). Assets are linked to your corporate risks and service measures through risk nodes and risk links. Each Risk node represents an asset risk or service measure driven by a probabilistic model, reliability model, consequence model or financial impact model (to name but a few).

Once the risk map is defined, each individual asset risk is calculated by following these simple steps:

1. Determine all directed paths from an asset node to a given node (following the direction of the risk links).

2. Calculate the product of all risk node models along each path (i.e. multiply the outcomes of all risk node model together) to provide the risk value of each path.

3. Sum the risk value of each path to give the total risk value for that risk node.

The outcome of these calculations provides the reactive risk positions at asset level when using the reactive models of each risk node. The proactive risk positions are calculated by using the proactive models of your risk nodes when and where applicable.

AIM uses the differences between the reactive and proactive positions together with the Intervention costs to determine your optimal Scenario solutions.

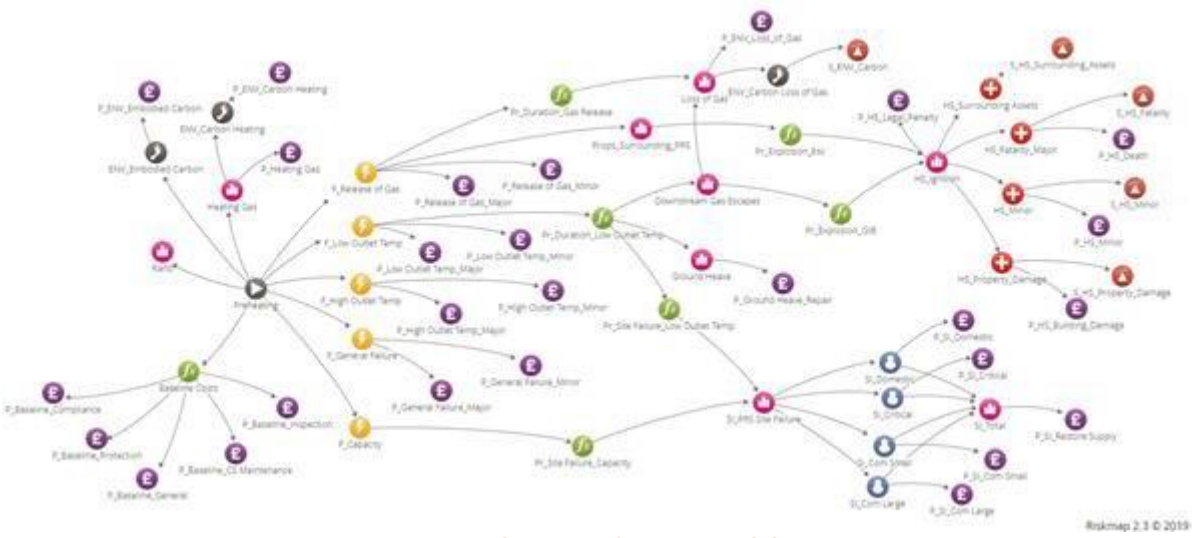


Figure 3: Six Step Model

We use probability of failure and consequence of failure estimates to underpin a range of investment options. We start with the minimum/reactive investment position, where we do not invest proactively, although we will continue to carry out maintenance and repairs. The probability of failure and consequence of failure estimates are used to assess risk and service under this minimum investment position.

This reactive only position is then contrasted with a range of different operational change or investment options. These options will involve incremental investment over and above the reactive position; these options will also impact differently on current and future service/risk as they affect elements of the FMEA calculation, such as reducing the probability of one or more failure types, or reducing the consequences of failure, or both. The risk reduction of each possible intervention option available is then calculated as the summed difference between the risks before and after intervention. This is possible to compute given all risks are monetised.

We optimise the plan through the selection of solutions providing the largest benefit per £ spent – tempered with deliverability, affordability and payback. The systematic quantification of risk reduction informs an ongoing prioritisation of the plan. Where CBA produces a different view from a traditional bottom-up development of our plan, we will work with business experts to refine both approaches towards a single solution.

3.2. ISO 55000

We are currently certified under the international standard for asset management, ISO55000. As part of this certification we undergo external audit by an accredited certification body, currently Lloyds. Adherence to these standards helps us to:

- Establish an asset management system to optimally manage assets
- Implement, maintain and improve an asset management system
- Comply with asset management policy and strategy
- Demonstrate that we are applying best practice

We undergo certification audits every three years, with annual surveillance audits for the years in between to ensure we are maintaining our asset management systems appropriately.

Following our most recent surveillance audit in February 2019 Lloyds stated that:
"There is evidence that Cadent Gas consistently develops and delivers work programmes in line with its strategy and objectives and undertakes activities in accordance with policies and procedures and that a risk-based approach is applied throughout the life cycle activities."

"***The business continues to deliver excellent results against a backdrop of significant change while continuing to meet its regulatory and legal obligations. Overall, evidence indicates that Cadent Gas operate an effective asset management system and numerous examples of Cadent Gas's commitment to continual improvement were evidenced during the assessment."***

Our accreditation demonstrates good asset management practices are in place.

3.3. Data Quality Improvements

Our data is critical to how we meet our commitments and deliver quality services to our customers, including the most vulnerable. As Britain's largest gas network, our data can also play a valuable role in propelling innovation throughout the sector and planning for a decarbonised and decentralised energy system of the future.

We are alive to the fact that poor data management practice can lead to severe consequences. To enable our Data & Digitalisation Strategy, we have embarked on a transformation programme across three building blocks of *technology*, *people*, and a robust *data strategy*. We are on a journey to become a data-driven organisation and have set in motion an ambitious programme that will establish data competency in the near-term, and sector-wide data leadership in the future.

Our Data & Digitalisation Strategy is set out in Appendix 07.02.02.

3.4. Benchmarking and Best Practice

We frequently meet with investment planners from other regulated business to review and compare good practice in asset management. We met with Network Rail (West Coast route) in January 2019 to review their recent business planning submission for their next regulatory period. In 2018 we met with the Canal and River Trust to compare our risk quantification models and with Severn Trent Water to discuss service design. We have also met with London Underground and the Environment Agency. Through the professionalisation of our asset-management teams, we have successfully completed certification and diploma courses with the Institute of Asset Management during 2018/19. These courses draw on the latest thinking across the industry.

We are therefore confident that our approach to asset management meets the requirements of good practice appropriate to our asset base.

3.5. Compliance with Ofgem Guidance

The approach outlined above aligns to the guidance that Ofgem has issued through the business planning process. These requirements are clearly embedded in our business-as-usual practices.

3.5. Conclusion

We deploy a range of tools and techniques to analyse information and to facilitate strategic decision making. We engage everybody with asset management responsibilities so that we have a complete understanding of issues and ensure everyone is committed to the same action, not only for proposed solutions but also to manage risk that we may not be able to address through investment. We want to draw on and combine the insights of our teams, analysis of past trends and our cost-benefit models to produce a single plan. We are committed to continuous improvement of our approach, building on both positive and negative feedback from customers and regulators to enhance the quality of our decision making.

4. Discharging our Legislative Requirements

We are mandated to deliver certain asset interventions to satisfy the requirements of legislation or regulatory enforcement. Compliance ensures that we deliver the standards which our customers and society expects. We continually review our approach to make sure that we are managing risk in the most appropriate way.

4.1. Safety

Safety is a primary consideration for us, our customers and employees. We are also mandated to meet certain safety standards set out in legislation – see table below (and Appendix 2).

Our largest area of investment – iron mains replacement – is covered by the Enforcement Policy for the iron mains risk reduction programme (IMRRP) 2013-2021 set by the Health and Safety Executive (HSE).

Instruments	Main legislative drivers
Pipelines Safety Regulations **(PSR – 1996) (PSR13a – 2003)**	As a pipeline operator we have duties under the Pipeline Safety Regulations: • Regulation 8 requires that our pipelines are constructed of a suitable material. • Regulation 9 requires that our pipelines are constructed so as to be sound and fit for purpose. • Regulation 13 requires networks to ensure that the pipelines they operate are maintained in an efficient state, in efficient working order and in good repair. • These duties are absolute.
Pressure Systems Safety Regulations (PSSR) 2000	These cover the safe design and use of pressure systems. The aim of PSSR is to prevent serious injury from the hazard of stored energy (pressure) because of the failure of a pressure system or one of its component parts.
Gas Safety (Management) Regulations 1996	As a gas transporter we have duties under the Gas Safety (Management) Regulations 1996 (GSMR). • To be able to convey gas in a network we have to prepare a safety case that is accepted by the HSE as per Regulation 3. • We have to conform with that safety case as per Regulation 5. • The duty to follow the arrangements in the safety case are only affected by the interests of health and safety and not any economic considerations.

Table 1: Legislative Instruments

We also have numerous other duties we need to satisfy in relation to being an owner of a large and varied asset portfolio. We demonstrate that we take reasonably practicable steps[1] in ensuring we don't harm our staff, our customers or anyone else that could come into contact with our assets.

[1] The Health and Safety Executive is responsible for making adequate arrangements for enforcement. In fulfilment of its duty the Executive provides guidance to its regulatory staff who have to judge whether measures put in place or proposed, by those who are under a duty to control and reduce risks "as low as is reasonably practicable" (ALARP), are acceptable.

These requirements are detailed further in Appendix 2 but include the following:

1. Control of Asbestos Regulations (2012)
2. Occupiers Liability Act (1957, 1984, 1995)
3. Health & Safety at Work Act (1974)
4. Construction, Design & Maintenance Regulations (2015)

Safety legislation is primarily enforced by the HSE with whom we have met regularly during the development of our business plan. While being clear that we are best placed to control the risks we create, they have stated that in the current climate they will not accept changes in approach which may be ‘perceived to decrease safety’.

Safety legislation drives most of our investment. Safety investment generally follows risk based inspection or monitoring which indicates that an asset is failing. We have set inspection programmes for the future and have observed the failure rates from past inspections, allowing the volume of assets requiring intervention to be calculated all other things being equal.

Survey periodicity is held in our core systems. Periodicity is systematically reviewed as part of business-as-usual processes, using condition data and deterioration trends as part of a risk-based approach. These meet with the requirements of legislation where this is explicit in terms of periodicity or where this has needed to be developed as an appropriate periodicity for inspection. These would tend to be developed using Approved Codes of Practice (ACoPs) or through reference to relevant policies. It is noted that the periodicity of some inspections can vary from that in other GDNs due to the nature of the current risk profile of the assets in question.

The inspection compliance described is a key part of the safety case which we have agreed with the HSE.

4.2. Other Legislation

We also need to satisfy existing and emerging Environmental Legislation, the most recent of these being the Medium Combustion Plant Directive (2015) - MCPD. This legislation is enforced by the Environment Agency and impacts our water bath heater fleet (see EJP 9.05)

Security XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX. In addition, we need to maintain cyber security defences to a government agreed standard.

4.3. Conclusion

It is important for us to understand what we are mandated to do and the element of legislation that underpins this. We have sought to ensure we have a clear connection between legislation and appropriate actions based on empirical periodicity or those developed by competent persons where this is not explicit. We have been clear on the relationship between the nature and frequency of our asset interventions and the legislation which drives those interventions.

85% of our gross plan has a legislative underpinning

Where appropriate, we have also been able to incorporate the views of customers and stakeholders into our legislative responses. Where there are genuine choices of the phasing of activity, or the way in which we comply, we have challenged ourselves to adapt our programme of work to incorporate these views. This is particularly evidenced in our planned approach to compliance with the IMRRP (Appendix 09.02 Distribution Mains and Associated Services).

We are able to evidence our actions to demonstrate that we are complying with our statutory obligations under various forms of legislation. We have tested our proposals with our regulators to ensure that we are delivering the standards they expect.

5. Costing Methodology

This section looks at our methods of constructing a cost for elements of work. It describes the costing mechanisms used to ensure our costs are as robust as they can be, demonstrating that they are realistic, take account of relevant cost drivers (including that they challenge efficiencies) and recognise appropriate regional variations.

There are three general approaches to costing:

- **Historic trend analysis and extrapolation:** Some work in the future is unknown in terms of the specific interventions and volume required but has well-established patterns of spending in the past. For example, we will invest money each year to replace high volumes of low cost Electrical and Instrumentation equipment, but the specific need is unknown. In these cases, costs have been based on historical trends from previous years, along with input from subject matter experts who can tell us if we are likely to see more or fewer incidences. These cost patterns are well established and high confidence. If costs are derived in this way, and we have identified changes in expected activity we will generally use an uncertainty mechanism to allow for variability in the forecast and to protect customers (for example diversions).

- **Like-for-like costing:** Where we have identified specific asset interventions for the future and have regularly delivered similar work, we have good historical costings that we can apply, as long as they are validated by relevant subject matter experts. For example, all things being equal, the cost of remediating a railway crossing of a certain length or rebuilding a heating system of a certain size will be the same in RIIO-2 as in RIIO-1. This approach takes account of cost drivers such as location or size to tune forecast costs to proposed work activity. These costs are high confidence.

- **New areas:** New areas require costing where we have little experience of previous investment. For these, we have sought the services of our supply chain, to input their expertise and experience, or used external specialist consultancy to help provide costs. Where possible we have used competition to help reveal the true cost of the service. Examples of this include the upsizing of pressure-reduction stations (‘capacity upgrades’) to meet growth needs, or particular projects such as the London Medium Pressure scheme. Even in these areas we can still draw on related experience. As we progress further through costing activities for new work areas we achieve high confidence in the costs

The approach will vary by asset group, with the level of sophistication varying, based on the materiality and complexity of the investment. Costs are based on the varying approach of average costing or on bottom-up costing and top-down costing. This is supplemented with three-point estimations based on prior experience or forecasting to give:

- the best-case estimate
- the most likely estimate
- the worst-case estimate

The costs established by these means reflect current work practices. A further layer of challenge is applied to build in efficiencies and look at new ways of working. This may require the production of additional cost estimates for consideration.

Our approach, which reflects best practice, follows a six-step model shown below and described in the next section.

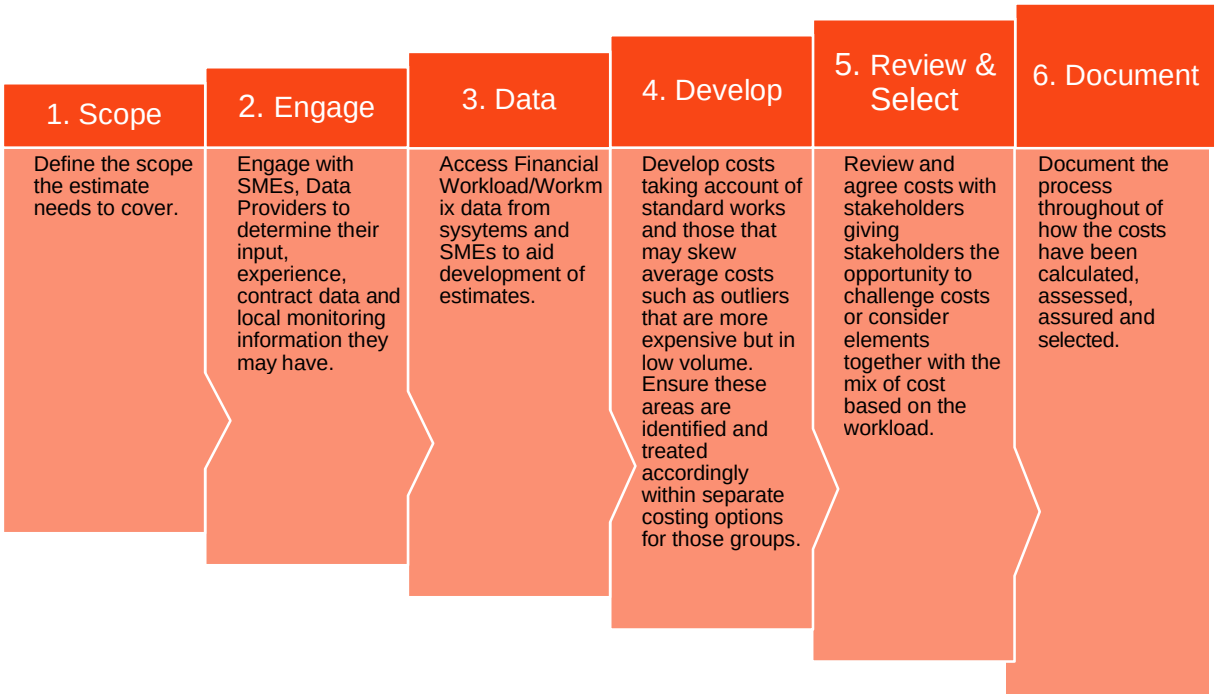


Figure 4: Six Step Model

1. **Define the Scope:**
   We determined the scope of each cost estimate, the required level of detail and overall scope of the estimate. We also determined which stakeholders would input to, review and agree the finalised estimate.

2. **Engage:**
   Stakeholder teams for the development of the cost estimates were established together with a schedule that included the potential estimating approaches based on the data and knowledge available. This included understanding any interdependencies and influences that may affect the work for each area, or the influences it may have on other areas. Certain SMEs provided costs directly as they were already in business-as-usual use.

3. **Data:**
   At this point, we created our data-collection plan, with emphasis on collecting current and relevant technical, cost, and risk data. We identified and investigated possible data sources (including core systems, quotations and feasibility-study costs) and collected data, normalising it for inflation and quantity adjustments. Data was analysed; SMEs were consulted for cost drivers, trends, and outliers, and results were compared. We used work-breakdown structures (WBS) of elements of cost from our financial systems (SAP) and through discussion with SMEs. This helped in establishing the best estimating method for each WBS element, identifying potential cross-checks for cost and schedule drivers.

4. **Develop:**

Costings were developed, estimating, where possible, each WBS element, using the best methodology from the data collected. All estimating assumptions were included and expressed in constant-year pricing (our plan is presented in 2018/19 prices). The models were updated as more data became available or as changes occurred. Where possible, the impact of sensitivity on cost elements was considered by identifying and exploring the effects on the overall estimate of changing the schedule, quantities or external factors and determining which assumptions are key cost drivers and which cost elements are affected most by change. Estimates were updated to reflect changes in technical or program assumptions to keep them current as each program passes through new phases or milestones. This included adjusting for overlap reduction with other investment lines.

5. **Review and Select:**
   This stage sought sign off from the owner of each investment line to confirm that they were content with the methodology and the outcomes in terms of the workload and costs.

6. **Document:**
   Throughout the process, we ensured that we documented all the steps used to develop the estimate, so that any individual unfamiliar with the investment line could recreate it quickly and produce the same result. This included all the detail in relation to the purpose of the estimate, the team that prepared it. This forms the basis of our methodology documents, discussed earlier in this appendix. This documentation also enables independent audit of the process to be conducted.

5.1. Articulating Cost Certainty

The material set out below feeds into the articulation of cost confidence in each of our investment methodologies. The analysis also feeds into 09.20 Resolving our benchmarking performance. External best practice reference material has been used to help us systematically quantify cost uncertainty (Figure 2). In the early stages of any project lifecycle there can be a high level of uncertainty relating to cost, due to the number of unknown issues that could lead to cost variance.

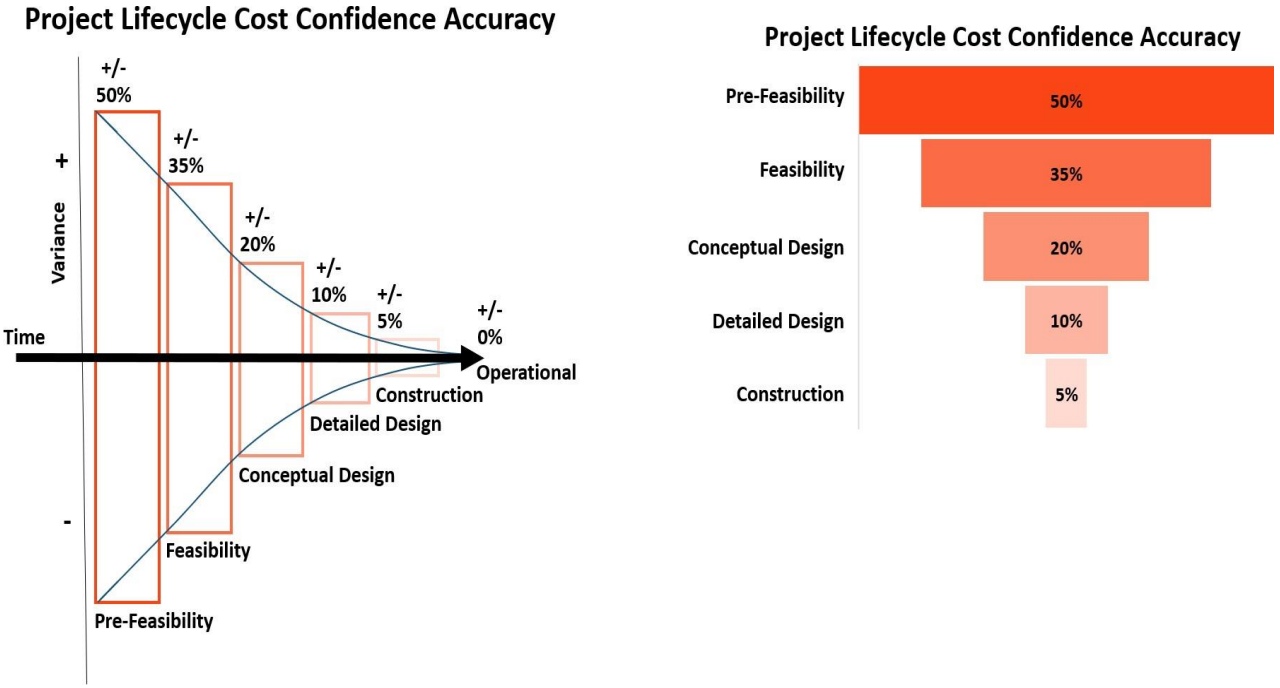


Figure 5: Project Lifecycle Cost Confidence Accuracy

This is particularly true for new areas of spend, but less acute for projects, which although being newly developed, are very similar to projects which we have delivered many times before. As the project progresses

and more data is gathered to understand cost drivers or if there is a high amount of data from similar historic works, the estimates become more certain meaning cost confidence increases. We also test the market where appropriate utilising competition to reveal the efficient cost of the work.

For example, we have not developed detailed designs for filter replacements in RIIO-2, as the specific units which will fail are unknown. We have however delivered hundreds of replacements of this nature during RIIO-1. For asset groups like this, which are low cost high volume, cost certainty is high despite the lack of detailed design.

Each of our investment appendices will reference the confidence in the cost estimate on the basis of the above model. Where there is high uncertainty we will seek to treat these projects as price control deliverables in order to protect the customer and ensure we don't benefit from a windfall should costs outturn lower than estimated. We are continuing to progress projects through their life cycle towards detailed design and as such cost confidence on a number of lines will continue to improve after submission.

The vast majority of our investment plan is continuation of existing work types and as such is high confidence.

Cost confidence across the investment plan

The application of the approach outlined above allows us to consider confidence across the plan as a whole. The distribution of cost confidence is shown in the figure below. Our most uncertain area of investment is London Medium Pressure (classified feasibility confidence ±35%) – which although a continuation of an existing work programme has a number of schemes specific challenges associated intrusive engineering in the centre of London. 85% of our investment, including our mains replacement programme, is estimated with a confidence within ±5%.

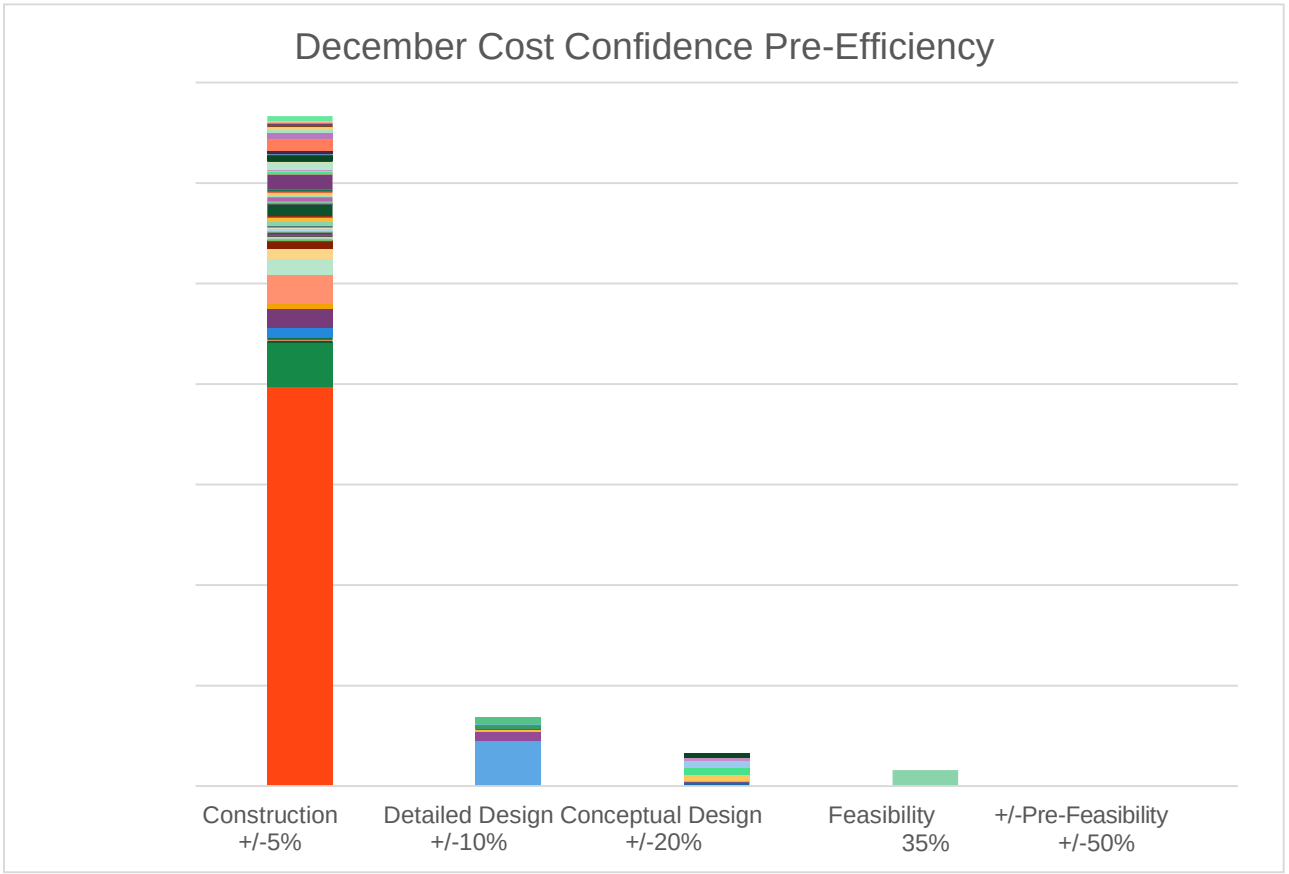


Figure 6: Cost Confidence Pre-Efficiency £m

Cost confidence levels reference per investment cases are tabulated in Appendix 5.

Cost estimation and efficiency

Our cost estimates and confidence intervals around cost estimates are developed prior to the application of challenging cost efficiencies. As such although we present cost confidence as symmetrical the post efficiency position will be asymmetrical with a reduced range of potential underspend and an increased range of potential overspend. This is illustrated in the image below which shows the application of a 10% efficiency. A cost estimate that was ±15% would, after the application of a 10% efficiency become -5% to + 25%.

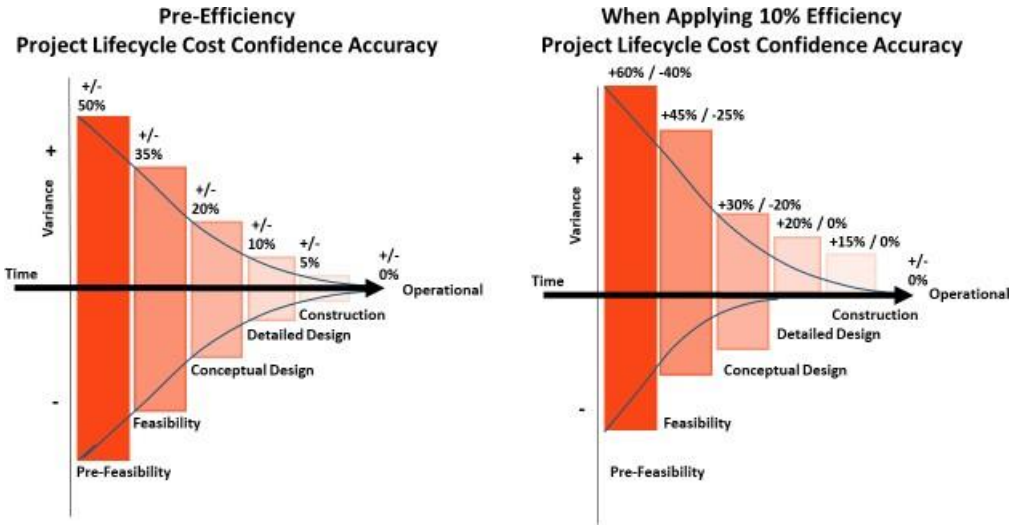


Figure 7: Cost Efficiency - Applying 10% Accuracy

6. Customer Preferences and Willingness to Pay

We have conducted extensive work to understand customers' wants and needs (see Chapter 5). Our approach to engaging customers has followed recognised good practice, for example our research has all been conducted by independent consultants in line with the Market Research Code of Conduct.

Following good practice, we have focused on the service to or outcome for customers rather than the technical aspects of the asset base or investment appraisal.

Customers have been clear from the outset of our engagement that safety and reliability are the core aspects of services. We have continued the conversation with customers to explore trade-offs between costs and different levels of service. Understanding these preferences has been the foundation for developing our business plan, directing the evolution of our service offerings, and steering the overall balance of our activity.

We have engaged with our customers to test options and the trade-offs they are willing to make. We have only considered realistic options (e.g. safety levels are only considered beyond the legal minimum levels). Customers views on the balance between safety, interruptions and environmental benefits has helped inform the development of our balanced plan. We have also explored whether these preferences alter between asset groups.

In addition to qualitative data on priorities and preferences, we have conducted research via economic consultants NERA to establish customers' willingness to pay valuations for changes to service and performance. This has been used to extend the valuation set already agreed as part of NOMS.

This has allowed our us to compare the cost of investment versus the benefits of investment in a robust and detailed CBA. The approach to gathering this information is described under phase 4 of our engagement approach.

6.1. Willingness to pay research

We have conducted independently assured willingness to pay research with our customers.

We engaged NERA to understand customers' willingness to pay (WTP) for improvements in the service provided by Cadent, covering both domestic and non-domestic gas customers.

The research consisted of stated preference research, revealed preference research and benefit transfer literature search.

The research was undertaken fully in line with best practice in the conduct of WTP surveys. This has included robust review and challenge from our stakeholders throughout the process, and independent peer review of the findings.

The research covered the following attributes:

- Interruptions
  - Restoring gas supply after short unplanned interruptions (3-24 hours)
  - How long the short interruption lasts;
  - Restoring gas supply after an unplanned interruption **lasting more than 24 hours**
  - Offering customers time slots for restoring gas supply;
- Safeguarding and vulnerability
  - Providing welfare services during interruptions
  - Measures to address fuel poverty
  - Connecting households in fuel poverty to the network
- Environment and communities
  - Reducing the proportion of gas lost through leakage
  - Proportion of gas that comes from green sources
  - Clearing up disused sites
  - Reducing the number of excavations in roads
  - Reducing the length of time it takes to carry out work.

To ensure valid WTP for this number of service attributes, the research was undertaken using a mix of stated preference exercises in the surveys.

- Discrete choice exercises - which seek to understand the trade-offs customers support. Customers are presented with different choices around service and the bill and asked to indicate their preferred choice. This is applied to a few attributes at a time, to ensure the choices are not too onerous for customers to consider. These responses are then statistically analysed to estimate customers' WTP for marginal changes in service.

- At the end of each survey, a contingent valuation exercise has been included. This combined all attributes together with a proposed bill to understand the maximum WTP for changes in all service attributes in the survey. The results of this are customers' maximum WTP for all

improvements being delivered. This can be used to scale the WTP from the discrete choice exercise values, to ensure that there is no overstating the valuations (which may arise from only considering a few attributes at a time).

In this way both scaled and unscaled valuations are estimated.

The research has been validated and triangulated with revealed preference research on the impact of supply interruptions and the benefits transfer literature such as the Ofgem/DECC value of lost load study[2], 2011. We have used this process to provide triangulated results as low, central and high valuations.

For domestic customers:

- Low: Nera used the lower-bound of the benefits transfer evidence
- Central: Nera recommended the scaled valuation from the stated preference research
- High: Nera use the unscaled valuation from the stated preference study

For non-domestic customers:

- Low: Nera has recommended a zero valuation in general, as the contingent valuation exercise in the stated preference study implies non-domestic customers have a zero valuation for further improvements in service
- Central: Nera recommended the midpoint of the Ofgem/DECC VoLL range for SMEs
- High: Nera recommended the unscaled valuation from the stated preference study

The results have been used in developing our plans. The valuations have supported our asset health and major projects investment plans, in our CBA based processes. They have also been used to support our approach to wider considerations, such as affordability and vulnerability assistance.

6.2. Societal Valuations

Our monetised risk model links failure modes, to probability of failure to their potential consequences. All of these are monetised in our assessments. Each potential consequence has been expressed as monetary values as per the agreed industry NOMs methodology. The valuations we have used to monetise societal impacts are outlined below.

Interruptions to supply

We have used the willingness to pay research to inform customers' valuations of interruptions. We have been conservative in the application of willingness to pay.

The final triangulated values from the willingness to pay research are:

[2] The Value of Lost Load (VoLL) for Electricity in Great Britain. Final report for OFGEM and DECC, 2011.

Unexpected Interruption (3-24h)									
				Domestic Customers			Non-domestic Customers		
Level	Unit	Range of service level		Low	Central	High	Low	Central	High
0 to +1	£ per interruption	1 in 250	1 in 400		Redacted due to commercial sensitivity				
+1 to +2	£ per interruption	1 in 400	1 in 550						
+2 to +3	£ per interruption	1 in 550	1 in 650						
Unexpected Interruption (24h+)									
				Domestic Customers			Non-domestic Customers		
Level	Unit	Range of service level		Low	Central	High	Low	Central	High
0 to +1	£ per interruption	1 in 2000	1 in 3000						
+1 to +2	£ per interruption	1 in 3000	1 in 4000		Redacted due to commercial sensitivity				
+2 to +3	£ per interruption	1 in 4000	1 in 6000						
(2018/19 price base)									

Table 2: WTP interruptions (from NERA)

We reviewed the impact of these valuations on our business plan. We observed that the central and high values could have a significant impact on CBA results – often producing results that seemed disproportionate. Therefore, we have been conservative in applying these valuations: we have used the lower bound estimates for the values of interruptions, i.e. £XXX is the value of preventing interruptions to a property (be that a domestic or non-domestic property). We have discussed this with NERA, and they support this practical approach.

For interruptions over 24 hours, we have used the low, central and high valuations depending on the severity of the duration. We have used the lower bound for interruptions in all of our asset health engineering justification cases; and in major investment justification cases where the impacts of interruptions would be up to a few days.

Some of our major investment justification cases are to prevent very long durations occurring in the future (i.e. to prevent very low-probability high-consequence events) – we have used the central value for interruptions where the impact may be up to one or two weeks, and the high case for interruptions over this.

We have applied a consistent set of valuations across the four regions, given the estimated values per region closely align, as shown below:

	3-24 hours	24hr plus low	24hr plus central	24hr plus high
North London				
West Midlands		Redacted due to commercial sensitivity		
North West				
East of England				
Average ALL				

Table 3: Regional WTP interruptions (from NERA)

Nera has used a mix of sources to develop the valuations, including stated preference research, revealed preference research and benefit transfer literature search. Other than the stated preference research, the values are the same across all four regions. In contrast, the stated preference study provides valuations that differ slightly by regions.

Nera's final recommendations provide a range of valuations based on the triangulation of all data sources available. We have been conservative in using the proposed values in developing our plans and have tended to opt for the low end of the values.

Using the lower valuations means we often use the values from the literature (e.g. Ofgem VOLL) which are consistent across the regions. Where we have opted to use the central or high values (e.g. where there can be very long interruptions significantly over 24 hours), this means we are using the results of the SP study. We have used a company average value,

We have run our CBA with and without these values so that their impact can be specifically isolated.

Environment – GHG emissions

Our willingness to pay research shows that customers have mixed views on the value of reducing greenhouse gas emissions and improving local air quality. Whilst customers have high valuations for increasing the proportion of gas from green sources, they are less definitive about the value of reducing emissions. In our CBA we have used HMT Green Book valuations. This recognises the increasing value of carbon overtime and therefore we consider this to be more appropriate to use over the long-term planning horizon of our business plan.

The price of carbon is an increasing figure, from XXXX tCO2e in 2021 to XXXX.12 tCO2e in 2071. We have used the base price of carbon for our analysis of options, although the high case values are included in the Ofgem template (whereby the price of carbon increases from XXXX tCO2e in 2021 to XXXX tCO2e in 2071) recognising that the government policy could increase carbon prices to support 2050 decarbonisation targets. Testing our plan using higher carbon prices only increases the cost benefit of our proposed investment. Hence to ensure our investment plan reflects 'least regrets', in developing our plans we have balanced the timely payback of our investment (and the risk of asset stranding for investment that pays back after 2050) with an assessment of value for money and affordability. Our approach to balancing these factors in explained in each EJP / MPJP. These figures and approach align with the Ofgem CBA template.

Safety – risk of injuries and deaths

We did not ask our customers about health and safety in our willingness to pay research. We have used the UK HSE valuations. These have been discussed and agreed with Ofgem. The values are:

- Cost per Fatality XXXXX
- Cost per Non-Fatal injury XXXXX

These figures match the Ofgem CBA template.

Other societal impacts

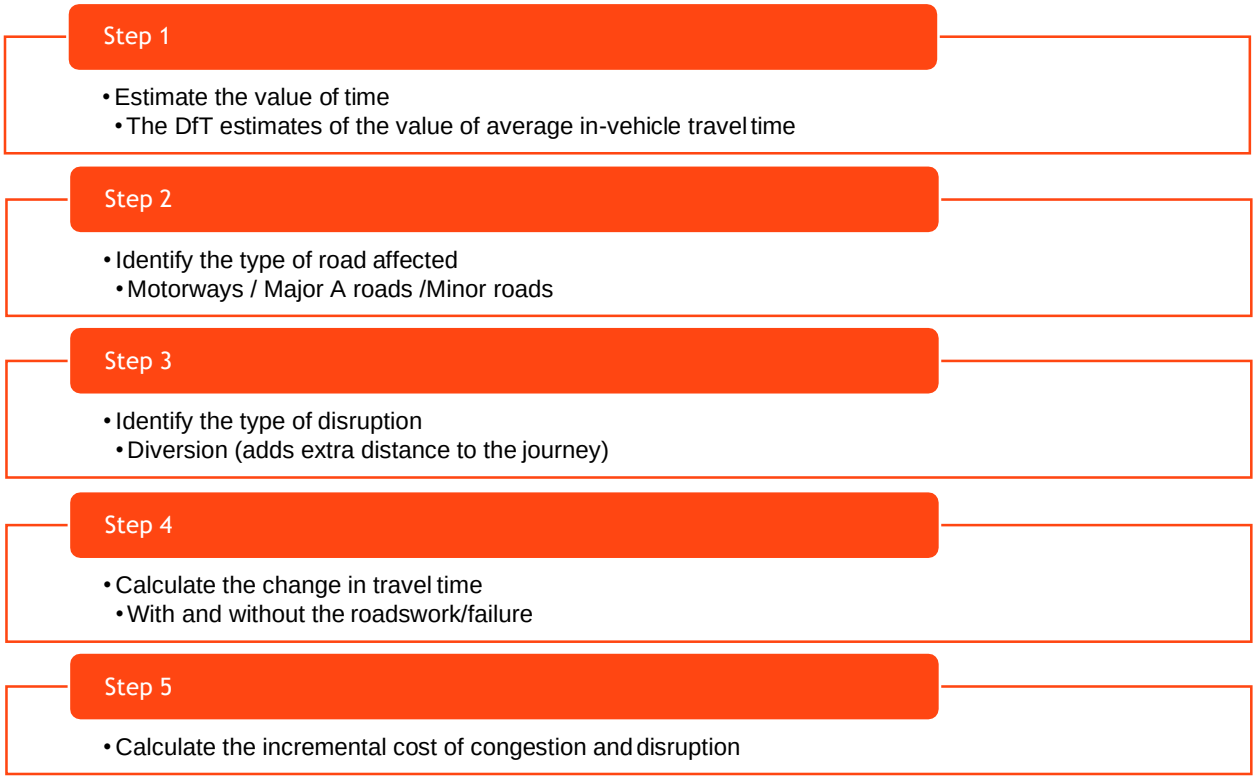
Our analysis includes wider impacts such as property damage and transport disruption.

Property damage varies according to region. These figures are based on average regional property price from HPI report Sept 2015. We apply inflation of 5.5% per annum as per current CBA. The values we have used are:

- EoE: XXXXXX
- Lon: XXXXXX
- NW: XXXXXX
- WM: XXXXXX

Transport disruption has been quantified through assessing the time lost as a result of road works or delays to rail networks. This could be as a result of planned works or an asset failure causing an interruption.

Our estimates of road transport disruption follow a best practice method that has been used in numerous regulatory price controls. Department of Transport (DfT) estimates for the value time of lost from disruption[3], national average traffic flows[4] and traffic speeds[5,6] for different road types, along with assumptions about the length of diversions have been used to assess the value of daily disruption to commuters, following the process set out below:



[3] Department for Transport "Provision of market research for value of travel time savings and reliability: Non-Technical Summary Report". 14 August 2015.
[4] Department for Transport statistics, Table TRA0302: Motor vehicle flow by road class and region and country in Great Britain, 2017
[5] Department for Transport statistics, Road Congestion Statistics Table CGN0501: Monthly and 12 month rolling average speeds on local 'A' roads in England
[6] Department for Transport statistics, Road Lengths Statistics Table RDL0101: Road lengths (miles) by road type and region and country in Great Britain, 2017

Figure 8: Five Step Process

Based on this process, transport disruption varies according to road type and length of impact.

- The valuation of traffic disruption to a motorway XXXX
- The valuation of traffic disruption to an A road XXXX
- The valuation of traffic disruption to a minor road XXXX

The value of a train delay is based on National Audit Office[7] data on the value of train delays per minute, inflated to 2018 prices, and the level of disruption (in minutes) expected when trains are disrupted, recognising the knock on effect of disruption on the rest of the network. Severe disruption is expected when strategic routes such as intercity services are disrupted (e.g. West or East Coast Mainline services); other routes are expected to have average delay figures.

6.3. Stakeholder Engagement

In addition to our work with customers we have also engaged with stakeholders including the HSE, BEIS and the Environment Agency to ensure that our interpretation of regulation (legislation) is aligned to their expectations. These meetings have allowed us to present and refine our thinking, and work towards a position of stakeholder support for our activities.

[7] National Audit Office "Reducing passenger rail delays by better management of incidents", 2008

7. Cost Benefit Assessment (CBA)

As outlined in our asset-management approach, we have developed robust economic principles to inform our decision making. This section describes how we have evaluated our investment options through good practice cost-benefit analysis, considering the impact of societal savings, environmental savings and the cost of capital over the life of the investment. Cadent's CBA policy is included in Appendix 3 top level CBA results are included in Appendix 4.

From the simple CBA models used for identifying work in RIIO-1, we have built a CBA decision-support tool that reflects good practice and fully aligns with Ofgem requirements. We are now able to conduct more comprehensive scenario analysis (including goal seeking optimisation) and quantify a wider range of benefits. We have developed consistent and systemised CBA models using the benefit values assigned in the NARMS approach. This analysis underpins around 69% of the net investment plan. Our approach not only discharges the requirements set out in Ofgem guidance but goes further in its assessment of benefits and optimisation across different asset classes.

For assets outside of the models, such as crossings, IS and Property, we have used the principles of CBA to inform decision making, and we have documented how this has been done. The whole submission (excluding third party driven work) is underpinned by CBA principles. In some cases, this has involved using Switching Analysis, in line with approach outlined in HM Treasury Green Book, to illustrate the level of an input variable (such as avoided costs or failure rates) that would ensure our proposed investments are value for money (further details on switching analysis are given in Appendix 4).

Our existing risk monetisation reporting tool (NARMS) already provides a good quantification of 'benefits' such as reduced carbon, property damage and repair costs. Further updates to our reporting models have enabled the production of CBA calculations to align to Ofgem guidance. We are taking our CBA methodology further, aligning to best practice in the Treasury Green Book, to incorporate willingness to pay data for interruptions.

Our approach is fully aligned to Ofgem's requirements:

- ✓ **Consistent with the HM Treasury Green Book**
- ✓ **Applies the Spackman approach to discounting**
- ✓ **Considered a comprehensive set of options, including 'reactive only' position**
- ✓ **Includes both opex and capex spends and savings**
- ✓ **Costs and benefits are in 2018/19 prices, exclude real price effects (RPEs) and net of expected productivity improvements**

Where Ofgem guidance documents on specific parts of CBA are defined, our default position has been to use the HM Treasury Green Book advice. This covers a range of advice on discounting, valuations, optioneering, and business case development.

Our adherence to this approach has been assured via independent consultant review.

7.1. Identification of Options

We have considered a comprehensive set of options which reflect a range of spend and risk profiles. We range from a 'reactive only' minimum cost position (which we call our baseline), to more costly options that deliver reductions in risk relative to the reactive only position.

We held workshops with our experts to develop a comprehensive set of options to consider. Overall, we have considered a range of options:

- The baseline – i.e. no proactive investment, but including maintenance and repairs
- Maintain costs to maintain stable risk – i.e. the total monetised risk across the five cost categories

- Minimise whole life costs – otherwise known as maximising whole life benefits
- Minimise costs to deliver legal obligations around safety and/or the environment
- Additional asset specific options, and combinations of all these options thereof

Additional scenarios have been considered that have been used to further understand the benefits of the options. For example, options that exclude customer willingness to pay values around reliability to see the impact this has on the results.

In response to the CBA assurance process, we have also tested changes to the capitalisation rates. This has not impacted our plans but has further demonstrated our plans are cost beneficial. See Appendix 4 for more information on the CBA assurance and capitalisation rates sensitivity.

7.1.1. Specifying the baseline

Defined baseline: We recognise our approach to defining the baseline is not always strictly within the baseline specified by Ofgem in the RIIO-2 guidance.

Ofgem guidance is for health and safety (H&S) mandated work to be covered in the baseline, with options for further work being considered in the CBA. However, including H&S work in the baseline means that we cannot value it as an option. By stripping it out as an option we can attempt to quantify an economic value for mandated work. This approach means that we are able to make wider use of CBA than would otherwise be the case.

Overall, we found it difficult to appraise the benefits of the safety interventions transparently. By removing these costs and benefits from the baseline and including them as options we have calculated their benefit compared to a do-minimum position.

Our approach is therefore to define the baseline as the option where we do not invest proactively in our assets, but we do inspect and maintain assets in line with our obligations, and repair assets under a fix on fail strategy to ensure a continuing service. This is the absolute minimum investment we can make in our assets. Other options are then considered which represent increments of investment over and above the baseline.

This approach to the baseline is the only divergence from the Ofgem guidance we have taken, and we have not taken this decision lightly. This approach to defining the baseline is in line with the NOMS methodology (which is consistent with other best practice such as the UKWIR common framework in the water industry). This provides the best way of appraising options in a transparent manner - and allows the cost differences - “deltas” - between the options to be considered and compared to each other.

In our approach all costs and benefits are clearly accounted for, the approach is transparent, and the most cost beneficial options can easily and readily be identified.

Not all options may be subject to full CBA costing. Where we reject options before full costing we have ensured the reasons for exclusions are identified and documented.

Zero baseline: Where possible, the do-nothing position and the options has been articulated in absolute terms, allowing a comparison of the options to the baseline and each other. There are some instances where the forecast baseline cannot be assessed. In these circumstances, the baseline is set at zero and in the options the changes in costs are considered, i.e., we include the costs of reacting to a failure occurring as avoided costs in each option, rather than as absolute levels of anticipated costs in the baseline.

This means that the template (non-baseline options) is populated with the proposed proactive investment, and the avoided private costs and avoided societal costs of the investment. This allows us to consider whether the proposed investment in RIIO-2 is value for money given the resultant expected change in performance and avoided costs over time.

From a pure CBA point of view the two approaches are equivalent – as CBA is all about comparing differences between options.

However, Ofgem's preference is for the baseline and options to be specified as absolute values, rather than deltas, as this provides them more information on the overall cost and risk position, and ensures all relevant costs are considered in the analytical framework. For example, if an investment were to change the further maintenance or repair costs, this would be clearly highlighted in the Ofgem recommended approach. Therefore, it is important to ensure that full scope of risks are costs is included in the CBA framework – whether these are specified as absolute levels or as changes/deltas.

We have been very careful to ensure that the full impact on risks and costs are included in all of our CBA assessments. Therefore, we can be confident our approach provides an accurate cost benefit assessment on which to base our options appraisal.

7.2. Identification and Quantification of Costs and Benefits

For each option included in the full CBA (i.e. a NARMS based CBA), costs and benefits have been identified in relation to the reactive only baseline-case costs and benefits. Benefits have been taken from the approved risk monetisation methodology. Costings have followed the Ofgem-preferred Spackman approach, and benefits include the monetised value of public (non-market) impacts.

The table below provides a summary of the valuations; see Section 6.2 for more details on the full set of valuations used.

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. EE 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 XXXX per day based on DfT data.*
Financial impact – cost of repairs (unit)	Company accounts.
Financial impact – cost of replacement (unit)	Company accounts. Benchmarked.

Table 4: Economic Valuations from the NOMs model

It is important to note that the CBA approach we have developed will not match exactly with the benefits assessment in NARMS. For example, Cadent's CBA model does include WTP information which is not in the NARMS model. Building this element into the model helps ensure we meet customer expectations around outcomes. There are also differences in discounting between the two approaches which Ofgem has discussed with the industry.

This is illustrated for repex in the diagram below.

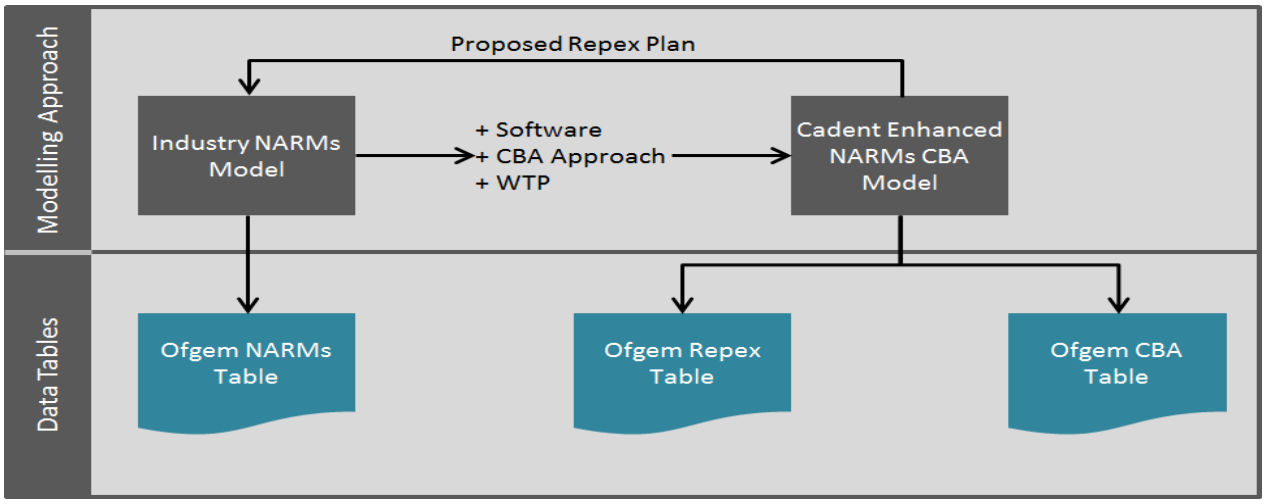


Figure 9: Schematic Showing Model Development and Sources of Data for Data Tables

In individual EJD we have also set out any impacts or factors that cannot be monetised, in order to build a richer picture of options and identify areas for future model refinement.

7.3. Period for Discounting Costs and Benefits

We have followed Ofgem guidance when considering timeframes for modelling. We have sort to best understand whole-life costs and benefits in the long term while also running shorter scenarios to understand paybacks (the time period for an investment to pay for itself through benefits realised) and plan sensitivities. This analysis allows us to understand and quantify the potential impacts of changes in the future of energy delivery - both 'no regrets' analysis and 'least worst regrets' analysis.

7.4. Decision Rules

CBA is a tool to support decision making. It has been applied at the project level, and most of the investment plan is made up of projects which have non-negative NPV.

Our investment plans have been informed by a detailed assessment of the costs and benefits of delivering different levels of risk and service. From this assessment we have selected the right option for our customers.

In principle we would wish to invest to the point where the marginal project has a non-negative NPV. This is the most cost beneficial level of investment. However, in some cases, we will not deliver all NPV-positive work, where it would produce changes in levels of cost that are not supported by customers. Similarly, we may choose to deliver negative NPV projects where these are supported by customers or mandated by external drivers (e.g. absolute duties within safety legislation). For legislatively driven work, a CBA may be attempted to help us understand benefits or to select options, but a positive CBA is not required for inclusion.

Therefore, in selecting and evaluating the options we have used the following criteria:

- Net present value (NPV) & Spend/NPV Ratio – in absolute terms, and also expressed as NPV per £ expenditure. NPV measures value for money and therefore options with the highest NPV are the most cost beneficial; but options with the highest NPV ratio provide the greatest value for money per £ spent.

- Payback period – to ensure that we deliver investment that provides outcomes to customers in a timely manner and reduces the risk of asset stranding.
- Level of RIIO2 spend – our customers and stakeholders are concerned about affordability so it is important to consider the level of spend, and question whether some or all of this can be deferred or delayed to RIIO3 and beyond.

Finally, we also recognise that non-monetised factors and engineering judgement also have a key role in assessing whether an option should be selected.

We have not applied a formulaic approach to assessing options. We recognise that CBA supports decision making – it is not the decision itself. We therefore consider the criteria above in a balanced way. In each EJP and MPJP we provide information on all of these criteria and how they have been balanced in reaching a decision.

7.4.1. Ensuring investments are efficient and balanced for our customers

Ofgem's RIIO-2 Framework Decision document published in July 2018 stated that "In an environment of increasing uncertainty around the volume, location and nature of future demand and supply for energy, there is broad recognition that we need to consider the risks of asset stranding and underutilisation through RIIO-2."

Like Ofgem, we are concerned about securing the best value for customers over the longer term in the context of uncertain future gas demands, consumer behaviour and government policy. Ofgem are concerned that potentially rapid changes in demand could lead to inefficiencies in how we invest in, and use, our network: for example, if there is investment in new networks to meet an expected demand, which does not last or cannot be sustained.

If the costs or benefits of a project vary over time from those originally anticipated, then the project may no longer present a positive business case and customers may therefore have funded an inefficient investment. Given that our assets often have very long lives, the cost-benefit calculation is very likely to change over an asset's life.

The payback period is the length of time for the benefits of the project to exceed the costs. Including projects with different payback periods has been useful for us in devising a suite of investment projects in the face of uncertainty, as a shorter payback period has potential for lower risk from changing energy policy and demands.

Our analysis is sophisticated enough to evaluate investment options against different payback scenarios and produce a plan which is most beneficial. Our CBA approach enables the basis for defending investments with a longer payback (i.e. demonstrating that some options have a lower whole life cost), as well as better quantification of benefits that could shorten payback times making them more acceptable to customers.

We have embedded CBA throughout our business planning processes, and this has provided consistency and rigor in the assessment of our plans. This is a significant step forward in putting customers at the heart of our business plans.

Since October we have made improvements to CBA:

- We have followed Ofgem guidance in completing and populating the CBA templates at secondary asset level.
- Whilst we think it is right to understand the RIIO-3 implications of RIIO-2 investment, it is not always possible to present a 10-year profile for investment, especially for our chosen option – often the next 5 years is not yet developed. For our December plan, we have considered a 5-year period for our options; where the 10-year period is known this is shown in a separate option, so the impact on RIIO3 is clear.

- We have reviewed and updated our modelling approaches, bringing our engineering and modelled assessments closer together – using the engineering assessments to enhance and improve the estimation of monetised risk in our modelling approaches.
- We have updated our company wide capitalisation rate estimates. We have applied significant capitalisation rate testing in our sensitivity analyses.
- We have applied switching analyses as alternatives to undertaking a full CBA assessment, where our data on the benefits of investment is less robust. This is an approach in line with CBA best practice were uncertainty is high. We have used modelled PoF or COF to support and improve this in practice.
- We updated and confirmed the valuation set underpinning the CBA, based on further assessment of our October business plans and additional literature research into transport disruption.
- We have and will continue to discuss our approaches and findings with stakeholders so that we can continue to ensure our plans reflect the right balance between value for money, affordability, and acceptability for our customers.

8. Asset health, criticality and replacement priorities

We maintain asset health to ensure compliance with our safety duties and deliver the service our customers need, at the right cost, through time. As such our approach to asset health and criticality starts with our customers and their needs – the fundamental need is a safe network. We have delivered extensive engagement programmes to understand customer preferences and then worked to identify how these can best be addressed through operational changes or investment. Customer preferences for safety, reliability and reduced environmental impact can be delivered by interventions to maintain or improve asset health. As such our asset strategy (and the required asset health level) is built in response to customer requirements.

The NARMS reporting tool allows different customer services requirements to be presented as a single figure for each asset group. Although the measure itself is not easily accessible to customers, it is a complex model of probabilities and consequences; it does provide a useful tool for understanding the investment programme as a whole. It contains elements, such as interruptions, that we have talked to our customers about. Having said this, it is also important to remember that the tool itself, although greatly improved through RIIO-1, is still a new mechanism and as with any model cannot capture all the nuances of a varied asset base.

We are still working closely with Ofgem and the other GDNs to conclude how we will present risk monetisation figures, through time (particularly how we articulate cumulative annualised benefit). Once these discussions are complete we will be able to expand our discussion of the NARMs performance measure.

The graphic below sets out asset health as calculated by our CBA methodology for our December submission. The left-hand area charts in Figure 9 show the risk position at the start of RIIO2 and how this will deteriorate in each of our networks without investment to the 2030 horizon. The right-hand charts show the impact of our chosen investment plan delivered over the same period. They show a gradual reduction in monetised risk through time, driven primarily by the IMRRP and associated services (yellow and blue areas). As we enter RIIO-3 and investment stops in the model the risk begins to increase again. It should be noted that there is a spike up in riser risk in RIIO-3, this results from the need to deliver additional surveys (an additional cost), 10 years after the bulk survey programme delivered in RIIO-1.

The second block graphs show greater granularity by asset. It should be noted that the monetised risk value is dominated by mains, services, and risers. The, asset by asset, comparison of risk with and without investment for Cadent as a whole using the analysis produced to support our CBA.

Individual components contributing to these overall trends are discussed in the following investment appendices. Final NARMs numbers will be calculated following completion of further technical work with Ofgem (see Appendix 6).

In determining our future risk position, we have begun with a principle that safety risk cannot increase through time. This creates a stable (flat) element within each of the models. In some circumstances the model does not fully capture a safety risk, for example the filters model does not fully represent the A1/2 defects which mandate replacement, to comply with PSSR. As such safety driven interventions identified by engineering assessment may create a reduction in monetised risk as represented in the model.

For non-safety risks we have used CBA and customer insights to shape our planed risk levels through time for individual asset groups. For each area of investment, we have assessed the costs and benefits for the option of ‘holding total risk flat’. We have also examined maximising whole life benefits. These options create different risk profiles through time. The risk presented in risk monetisation is a representation of ‘benefits’ that can be applied in a CBA. If removing risk is cost beneficial, we may propose that risk investment is delivered to improve asset health and as such we would see risk reduce through time. Conversely, where costs relative to benefits are high we may choose to allow monetised risk to increase. Where we are not bound to deliver specific regulatory benefits cost benefit assessment is an appropriate tool to help inform our asset health position.

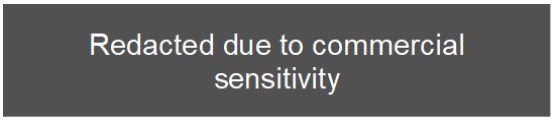


Figure 10: Asset Health – NOM's technology December 2019

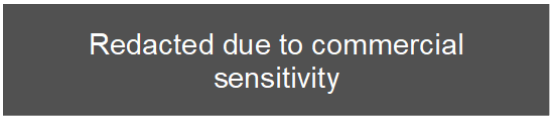


Figure 11:Asset by Asset Risk Comparison

9. Assurance and Challenge

Cadent has designed an assurance process to provide high level assurance to our Board. This approach is set out in more detail in Chapter 12 Assurance and Appendix 12.01 Our Assurance Framework & Evidence.

Within this section we have focussed on expanding on some of the key assurance activities specifically related to the Engineering Investment Decision Packs (IDPs), which comprise the Engineering Justification Papers, Cost Benefit Analysis and the related NARMs and BPDTs associated with these IDPs.

In producing our IDPs we have followed a number of key steps to ensure the investment cases are founded on robust data and were developed in compliance with our ISO55001 accredited asset management process. Our asset management process also delivers compliance with our legal and regulatory requirements as well as delivering value for customers. We have also implemented a strict review and governance process to ensure that subject matter experts with the relevant expertise develop the plans, which have been separately and independently reviewed by regulatory economic consultants and proof-read by an external advisor as well as being reviewed by, our senior leadership team and Board, and; challenged and supported by the Customer Engagement Groups (CEG) and Finance and Investment Working Group (FIWG). The key steps are set out below:

- **Data provision and assurance:** We have worked closely with data owners and SMEs from across the business to provide data and engineering expertise to inform these investment cases. This has been assured through the application of the Data Assurance Guidelines (DAG) process to CBAs, BPDTs and CBA models.
- **Comprehensive methodology documents**: We have documented our overall process for developing our capex and repex plans which have been reviewed by our second line assurance providers, PwC. We have also produced comprehensive internal methodology documents to record the development of our investment plans which has been reviewed and approved by key SMEs within the business and have been subject to external assurance by PwC, Costain and Lloyds.
- **Ongoing engagement with Cadent senior leadership:** Our asset strategy sub-group (ASSG), attended by our senior leadership team and directors, considered investment proposal outputs for compliance with strategy and that they were fit for purpose. These included a review and sign-off phase.
- **Periodic engagement with dedicated sub-groups:** We have undertaken planned engagement with our CEG, specifically focussed on the FIWG.
- **Focussed engagement with our Board:** Our Board have been intimately involved in the development of our plan. The outputs from work at the CEG and Asset Strategy Sub-group fed into sessions with both our Executive Team and Board, that allowed extensive challenge and review.

Area of Assurance	Provider of assurance	Approach
Asset management approach	Lloyds Register	Assessment of our methodology; specific deep dives into specific investment line.
Costing Methodology	Costain	Review of overall approach and detailed review on specific investment lines.
Economic modelling (CBA and use of WTP)	NERA	Assessment of our approach; deep dives into specific investment line. (6 CBA models)
BPDT production and methodology	KPMG	KPMG provided a review of specific inputs files that feed data to BPDTs covering the structure of the files, linearity, hard coded inputs in these files, and a detailed review of unique formulae where required.
NARMs modelling (population of tables)	ICS Consulting Ltd	Testing of the models built for NARMs reporting against the industry published NOMS methodology.

Table 5: Specialist assurance undertaken on our Investment Cases

In accordance with our assurance process, in areas of particular complexity we have employed specialist external third-party suppliers to assure the work we've undertaken. External assurance has been completed in the following areas:

This specialist assurance began in July and was concluded in December where the specialist providers were able to provide assurance that recommendations had been successfully implemented.

The following table summarises the Assurance Provider's actual findings as stated in their final reports or supporting commentary.

Assurance Provider	Summary of Findings
NERA	*"We concluded that Cadent's CBA modelling had been performed to a high standard, and its approach in the sampled models conformed with Ofgem's guidance, with one exception."*
ICS Consulting	*"The review concluded that the production and completion of Cadent's NARMS tables have been undertaken in a manner consistent with the published NARMS Methodology."*
Costain	*"Investment line costs are accurate, fairly represented, and are in compliance with the RIIO-2 Sector Specific Methodology Decision – Gas, Cadent policy documents and accepted industry principles and standards. "*
KPMG	*An analysis of the overall data flow and linkages between the specific files that were reviewed and identification of any issues for resolution by Cadent.*
Lloyd's Register	*"Cadent Gas are demonstrating an asset management approach to investment planning and business plan preparation consistent with their externally certified asset management system and industry good practice, and which involves customer engagement, understanding of drivers, analysis of asset condition, performance and criticality data, evaluation of costed options and prioritisation based on risk and other appropriate driver."*

Table 6: Summary of Assurance findings

We designed our assurance programme to ensure that Costain & Lloyds Register undertook complimentary, and in some cases overlapping assurance activities to fully cover our approach. The following diagram highlights the scope of their respective audits, and the inter-relationship between them. Due to the identified overlaps, we are confident that we have had a comprehensive set of external audits completed on our methodology to deriving our Investment Decision Packs and the supporting approach to costs.

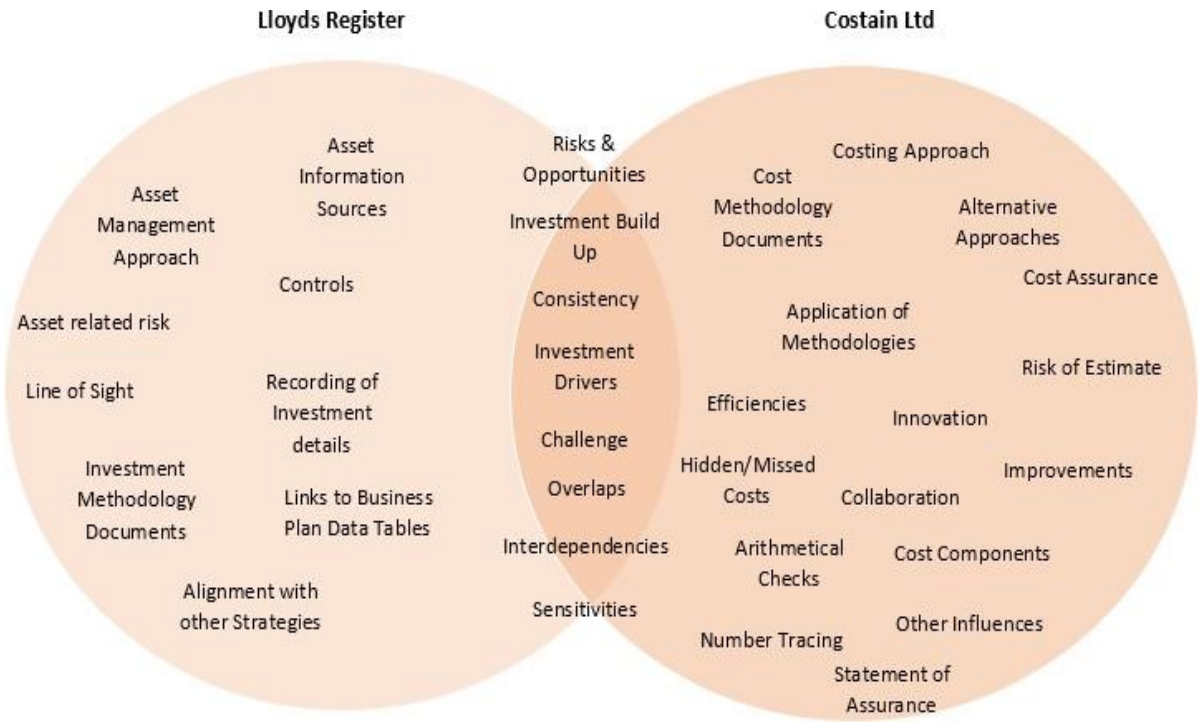


Figure 12: Scope of Lloyds Register & Costain Assurance

10. Investment Conclusions

Having researched customer preferences and understood legislative requirements, we have applied good asset management and economic appraisal techniques to build a robust plan. This plan has been presented to our CEG and Board and is being tested with customers.

We have a clear understanding of Ofgem's CBA requirements. We have built a CBA model around our NARMs reporting tool. CBA underlies all elements of our submission with around 69% of the net investment going through the tool and other areas having a simple CBA applied, using the principles set out in our policy. CBA will remain one input into our wider decision-making process, which will remain focused on delivering the right outcomes for our customers and stakeholders.

The details of investment for individual areas of the plan are included in the submitted Engineering Justification Packs.

We are confident that the plan we have developed discharges our legislative duties, improves performance, reduces costs and delivers positive outcomes for customers and stakeholders.

Appendix 1. Asset Management Policy

Asset Management Policy T/PL/G/30

Published: 14/05/2019 **Review date:** 14/105/2020

Our purpose is to keep the energy flowing

How we operate:

- Local understanding, national impact – dedication to keep our customers warm, safe and connected. Using the brain-power of our network to feel local by playing our role in communities.
- Legacy, pride and reputation – continued engineering excellence, dedication to safe and reliable service at the best prices.
- Expertise and innovation – pursuit of performance innovation, creativity and technology. Advancing, through our adaptive and forward thinking.
- Delivering in these areas is underpinned by the way we manage our assets.
- Asset Management applies to all network assets through their lifecycle.

We will work together to demonstrate:

Commitment

- Comply with regulatory and statutory requirements
- Ensure our operational and capital plans are balanced to reflect the needs of all stakeholders, both now and in the future.
- Maintain asset data to defined accuracy levels, ensuring it is available to all relevant users. Use high quality data to make informed risk based decisions.
- Deliver solutions based on the balance of whole life cost, performance, opportunity and risk from our operations.
- Recruit, train and develop our people and provide them with the resources to competently manage our assets

Community

- Engage with our customers and develop interventions that reflect their needs.
- Ensure that assets are designed constructed and maintained to be safe for employees and the public through their lifecycle.
- Ensure everybody has clear roles and responsibilities.
- As a process-led organisation we use lean methodologies to ensure that inter-related activities, roles and responsibilities are understood across the business.

Courage

- Operate a programme of continuous process improvement, making sure our asset management approach is always up to date.
- Embrace continual improvement of asset management practice using assessment and measurement of our asset management maturity to create improvement road maps to develop beyond the competent level into optimised and excellence.

Curiosity

- Utilise real time information to analyse and report performance and inform decision making and our operational and capital plans.
- Benchmark our activity against external best practice, obtaining certification where appropriate.

John Duckworth
Network Strategy Director

Cadent
Your Gas Network

Appendix 2. Investment Underpinned by Legislative Drivers

Investment Line	Relevant Legislation
Above Ground Crossings Inspections >7bar	Occupiers Liability Act 1957/ Occupiers Liability Act 1984/ HSAWA/ PSR 1996
Cathodic Protection Stray Current System	PSR 1996
Cathodic Protection Stray Current System Inspections	PSR 1996
Civils Structures	Occupiers Liability Act 1957/ Occupiers Liability Act 1984 HASAWA
DSEAR Interventions <7 bar	DSEAR 2002
Enabling an OLI1 Pipeline Inspection	PSR 1996
HI4 Inspections	PSR 1996
High Pressure and Intermediate Pressure Cathodic Protection	PSR 1996
High-Pressure and Intermediate Cathodic Protection Inspections	PSR 1996
HP Valves (Pipeline)	PSR 1996
HP Valves (Pipeline) Inspections	PSR 1996
HP_IP Valves (Non-Pipeline)	PSR 1996
Interventions Following Above Ground Crossings Inspections <7bar	Occupiers Liability Act 1957/ Occupiers Liability Act 1984/ HSAWA/ PSR 1996
Interventions Following Above Ground Crossings Inspections >7bar	Occupiers Liability Act 1957/ Occupiers Liability Act 1984/ HSAWA/ PSR 1996
Interventions Following Above Ground Crossings Inspections for the Access Deterrent Mechanism <7bar	Occupiers Liability Act 1957/ Occupiers Liability Act 1984/ HSAWA/ PSR 1996
Interventions Following Above Ground Crosssings Inspections for the Access Deterrent Mechanism >7bar	Occupiers Liability Act 1957/ Occupiers Liability Act 1984/ HSAWA/ PSR 1996
IP_MP Valves (Pipeline) Inspection	PSR GSMR
Line Walking and SRP Inspection	PSR 1996
Medium-Pressure and Low-Pressure Cathodic Protection	PSR 1996
Medium-Pressure and Low-Pressure Cathodic Protection Inspections	PSR 1996
MEG Installations	No Current Legislation Aligned
MP Valves (Non-Pipeline) Inspections	PSR GSMR
OLI 1 Inspections	PSR 1996
OLI 4 inspections	PSR 1996
PIG Trap Inspections	PSSR 2000
Pipeline Marker Posts	PSR 1996
PRI Pipe Supports	PSR 1996
PRI Protective Coating	PSR 1996
PSSR Filters Inspections	PSSR 2000
PSSR Preheating F-Schedule Inspection Programme	PSSR 2000
River Bank and River Bed Inspections <7 bar	PSR 1996
River Bank and River Bed Inspections >7 bar	PSR 1996
Site Signage	Safety Signs and Signal Regulations 1996
Sleeves	PSR 1996

Appendix 3. Cadent CBA Policy

The full policy can be provided on request.

Appendix 4. CBA Results and Sensitivity Testing

Our approach to undertaking CBA is in line with the Ofgem guidance and best practice. We have employed NERA consultants to review and assure our CBA processes.

The assurance process has shown that we have followed the Ofgem guidance in principle and in practice.

Top line results

The table shows the NPV for each of the areas where CBA has been completed, illustrating at least XXXX of benefits of the periods analysed. The elements of our plan which have had a CBA completed have a combined payback of XX years.

		NPV £m (2018/19 price base post efficiency)
9.02	Distribution Mains and Associated services (Iron, PE, Steel & Other) - CBA	
	Distribution Mains and Associated services (Iron, PE, Steel & Other) - Safety	
	Distribution Mains and Associated services (Iron, PE, Steel & Other) - IMRRP	
9.03	Services Not Associated with Mains Replacement	
9.04	Transforming the experience for Multiple Occupancy Building customers - Risers	
9.05	Offtakes & PRS Pre-Heating	Redacted due to commercial sensitivity
9.06	London Medium Pressure	
9.07	Offtakes & PRS Slamshut Regulators	
9.08	Governors (District, I&C and Service)	
9.09	LTS Pipelines (Piggable and Non Piggable)	
9.10	Offtakes & PRS Metering Systems	
9.11	Offtakes & PRS Odourisation Systems	
9.12	Security Interventions National Cat2a	
9.13	Brunel Bridge Crossing Refurbishment	
9.14	Offtakes & PRS Filters	
9.15	Holford Salt Cavity E&I	
9.16	Winnington Lane Crossing Replacement	
9.18	Mersey Tunnel Access Refurbishment	
9.28	Corporate Property	
9.30	IS	
9.32	Reduced Depth of Cover >7 bar	
9.33	Pipeline Sleeves	
9.35	Cathodic Protection	
9.36	Pipeline Crossings	

Switching Analysis

Switching analysis, as set out the in Her Majesty Treasury Green Book, is a form of sensitivity analysis that identifies the input values required to change the cost-benefit analysis results.

> *'A switching value refers to the value a key input variable would need to take for a proposed intervention to switch from a recommended option to another option or for a proposal to not receive funding. (HM Treasury Green Book, p33)*

This approach is particularly useful where there are significant future uncertainties, making specification of accurate risk scenarios problematic. It is the most appropriate approach to Cost-Benefit Analysis where input values are somewhat uncertain, such as the probability of failure or the level of avoided costs. This is particularly useful for high consequence low probability events where there is not a failure date set to draw from.

As set out in The Green Book, we have used the switching analysis approach to identify the input value that would make the programme breakeven – i.e. the switching point. We have used expert judgement and case studies to review this switching point and assess whether it is a reasonable to assess the programme as cost beneficial or not.

For example, it is difficult to quantify the likelihood of a member of the public dying as a result of trespassing on our assets. The risk is real, we have had a fatality in RIIO-1, but generating a probability of failure for inclusion in CBA analysis is problematic. We can however quantify consequence and we know the costs of intervention. As such we can set the NPV at zero (the break-even point) and rework the CBA calculation to calculate the missing probability figure. We can then assess whether it is reasonable that this figure would be exceeded, in which case the CBA would be NPV+.

Paybacks in CBA

The application of Ofgem's guidance in CBA, results in upfront capital costs being spread over the life of the investment, reflecting the way in which the costs impact on bills. The costs per year are thus much reduced from the actual investment levels in each year.

<u>Illustration</u>

Consider a *XXXX* investment which generates *XXXX* of benefits per year (e.g. avoided costs, environmental risk reductions, etc).

The *XXXX* of investment is recovered through customer bills over time (through finance costs and depreciation). Using a capitalisation rate of 100% (as per Ofgem's guidance for repex) and our WACC of 3.23%, this would result in costs to be recovered of *XXXX* across a five-year period:

- *XXXX* in year 1
- *XXXX* in year 2
- *XXXX* in year 3
- *XXXX* in year 4
- *XXXX* in year 5
- And so on….

Note: year one will be low as there are no depreciation costs until year 2.

This project would immediately payback for our customers – they would experience higher benefits than costs from the first year of investment (i.e. *XXXX* of costs and *XXXX* of benefits in the first year).

If we did not capitalise the investment – then this project would not pay back for several years. In this example it would take 11 years for the discounted sum of the benefits to exceed the discounted costs.

This shows that where capitalisation rates are high, and where benefits are relatively large and emerge early in the programme, it is possible to get very short paybacks against discounted capital expenditure.

We have followed Ofgem's guidance in discounting and setting capitalisation rates. We have calculated paybacks using a clear definition: the point at which the discounted stream of benefits to our customers starts to exceed the discounted stream of costs they incur through their bills.

Illustration – portfolio effects

In our portfolios of work (e.g. mains replacement) there will be a mixture of schemes that have different costs and benefits, NPVs and payback periods.

When looking at the portfolio as a whole those projects with a short payback will counterbalance those with longer payback – to give the average payback for the portfolio.

For example, a portfolio with three schemes with individual payback periods of 5 years, 10 years and 20 years may have an average payback of c. 12-15 years (depending on the level and profile of costs). This would be a good payback for the portfolio.

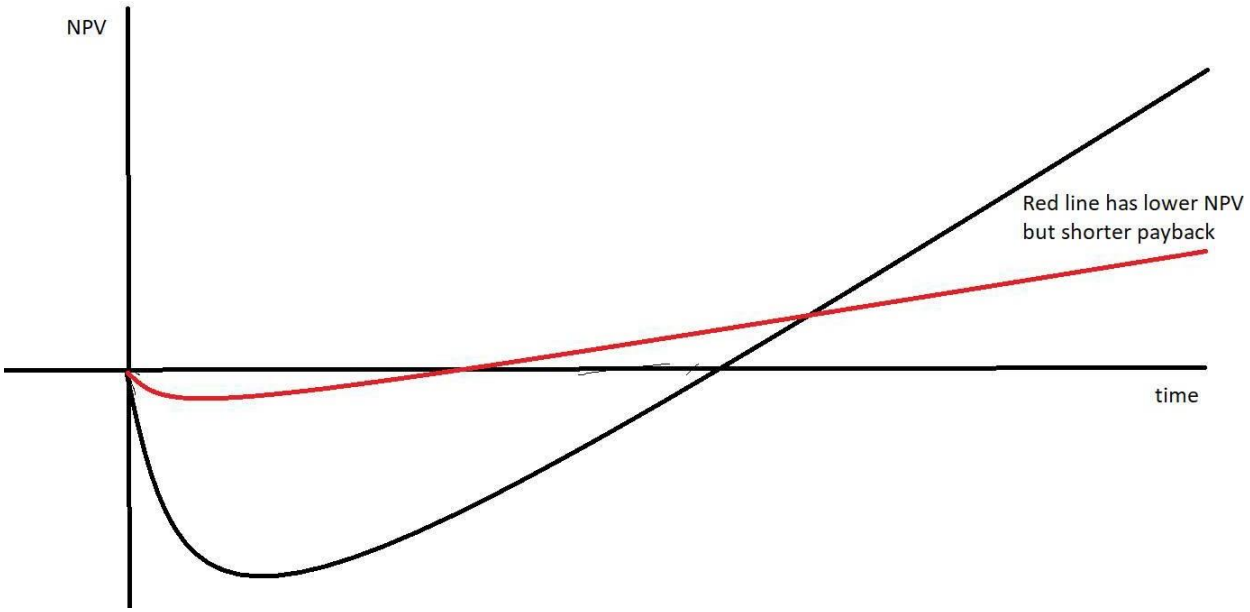
We have strived to ensure projects that make up our investment portfolios do have reasonable payback periods and maximise cost benefit within the constraints set.

Illustration – high payback versus high NPV

We recognise that NPV and payback are not the same.

In seeking the best solution, we aim to maximise whole life benefits (NPV) subject to constraints. We have, however, questioned the validity of positive NPV portfolios with long paybacks (for example, if benefits accrue quite far into the future).

In the figure below we demonstrate this point. In this example we can choose between the black or red line. From a purely economic point of view, the black line is preferable as it has the highest NPV. The red line has a shorter payback period, i.e. the point at which the discounted stream of benefits to our customers starts to exceed the discounted stream of costs they incur through their bills occurs sooner. As such in choosing the right investment option for our customers, we would consider both the NPV and the payback, in relation to overall expenditure.



We consider it important to consider the CBA results without applying formulaic rules. We have always considered and balanced our legal duties, affordability, value for money and payback in reviewing and finalising our investment plans.

Capitalisation Rates

Ofgem guidance states that companies should use a *"company-specific capitalisation rate, based on the average of their expected capex and opex spend profile over RIIO-GD2. For repex spend, companies should assume capitalisation rate of 100%".* That is, apart from repex all CBAs should use the same company-wide capitalisation rate.

The capitalisation rates used in our financial model following finalisation of the totex plan are set out below. These are based on the 5-year average of capex / (capex + opex). These can be found in Row 99 of the Ofgem LIMO Network Sheets.

Capex / Opex Capitalisation	2022	2023	2024	2025	2026	Average
East of England						
London		Redacted due to commercial sensitivity				
North West						
West Midlands						
Cadent						

Our response to this guidance has been to:

- Apply our specific capitalisation rate of *XXXX*
- Apply a consistent 100% capitalisation rate to any repex programme (whether fully or partially repex).
- test sensitivities around the assumed capitalisation rates.

To test sensitivities, we have tested the company wide capitalisation rate *XXXX*, 100% and 0% capitalisation rates for all modelled and manual[8] investment areas. This has allowed us to review the impacts on the CBA results – and challenge if this would change our plans. This is an important test – given that CBA is not the only consideration we make in developing our plans.

The high-level results from testing capitalisation rates is shown below:

[8] With the exclusion of the switching analyses.

		Capitalisation rate					
		100%		27.69%		0%	
		NPV £m	Payback	NPV £m	Payback	NPV £m	Payback
9.02	Distribution Mains and Services - CBA						
	Distribution Mains and Services - Safety		Redacted due to commercial sensitivity				
	Distribution Mains and Services - IMRRP						
9.03	Services (Individual)						
9.04	Risers						
9.05	Offtakes & PRS Pre-Heating						
9.07	Offtakes & PRS Slamshut Regulators						
9.08	Governors (District, I&C and Service)						
9.09	LTS Pipelines						
9.1	Offtakes & PRS Metering Systems						
9.11	Offtakes & PRS Odourisation Systems		Redacted due to commercial sensitivity				
9.13	Brunel Bridge Crossing Refurbishment						
9.14	Offtakes & PRS Filters						
9.16	Winnington Lane Crossing Replacement						
9.18	Mersey Tunnel Access Refurbishment						
9.28	Corporate Property						
9.3	IS						
9.36	Pipeline Crossings						

Note:

- NPV is the discounted sum of costs over time relative to our do-nothing position (known as the baseline position). In estimating NPV, we have considered costs over five risk categories: financial, environmental, safety, reliability and other costs.
- All costs are discounted in line with Ofgem's recommended approach, for example financial impacts are discounted using the Spackman approach. A positive NPV means an option reduces the profile of costs relative to the do nothing (baseline) position and is therefore cost beneficial. The option with the highest positive NPV is the most cost beneficial option.
- Payback in the table above shows the year when the sum of costs associated with an option is lower than 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.

These results show that the preferred option remains cost beneficial in all cases. The exception is LTS pipelines – for which the mandatory safety led work is non cost beneficial in all circumstances.

Investments with a shorter payback are most affected by the change in capitalisation rates.

Overall, we conclude that the sensitivity around the capitalisation rates does not change our view that our plan is very cost beneficial and value for money for our customers.

Appendix 5. Cost Confidence Reference Table

Cost Confidence Range	Project Maturity Stage	Description
+/-5%	Construction	We are experienced in delivery, having strong technical knowledge, bottom-up research, developed with detailed designs and unit costs. The amount of uncertainty decreases, eventually approaching zero.
+/-10%	Detailed Design	We have experience in delivery, have good knowledge, research, in development with semi-detailed designs and unit costs.
+/-20%	Conceptual Design	Project is in early phase of design interactions and strategic development. Outlining scope and requirements, able to use principles and knowledge from other projects.
+/-35%	Feasibility	In strategic, pre-design and pre-study stage. Limited knowledge of specific details with much greater assumptions and estimates made.
+/-50%	Pre-Feasibility	Estimates are made for strategic business planning, assessment of viability, using ballpark, guestimates, rough order of magnitude.

Figure 13: Cost Confidence levels during a project lifecycle, adapted from the Association for the Advancement of Cost Engineering

		Cost Confidence Level Pre-Efficiency (Cost in £m)					
Submitted Appendix	Project Title	Construction +/-5%	Detailed Design +/-10%	Conceptual Design +/-20%	Feasibility +/-35%	Pre-Feasibility +/-50%	Weighted Confidence +/-%
9.02	Distribution Mains and Associated Services						2%
9.03	Service Not Associated with Mains Replacements						2%
9.04	Transforming the experience for Multiple Occupancy Building Customers						9%
9.05	Offtakes and PRS Pre-Heating						14%
9.06	London Medium Pressure						35%
9.07	Offtakes and PRS Slamshut Regulations		Redacted due to commercial sensitivity				10%
9.08	Governors (District, I&C and Services)						10%
9.09	LTS Pipelines (Piggable and Non Piggable)						5%
9.10	Offtakes & PRS Metering Systems						19%
9.11	Offtakes & PRS Odourisation Systems						20%
9.12	Security Interventions National Cat2						15%
9.13	Brunel Bridge Crossing Refurbishment						14%
9.14	Offtakes & PRS Filters						5%

		Cost Confidence Level Pre-Efficiency (Cost in £m)					
Submitted Appendix	Project Title	Construction +/-5%	Detailed Design +/-10%	Conceptual Design +/-20%	Feasibility +/-35%	Pre-Feasibility +/-50%	Weighted Confidence +/-%
9.15	Holford Salt Cavity E&I						13%
9.16	Winnington Lane Crossing Replacement						15%
9.17	Category 3 Mandated National Security Upgrades						20%
9.18	Mersey Tunnel						20%
9.23	Capacity Upgrades - > 7 bar reinforcements (AGIs) - Base case						26%
9.24	Pipeline / Mains Diversions - Non-Chargeable > 7 & < 7 bar - Base Case						5%
9.25	Pipeline / Mains Diversions - Chargeable <7 & > 7 bar - Base Case		Redacted due to commercial sensitivity				5%
9.26	Mains Reinforcements - Base Case						5%
9.27	Connections - Base Case						5%
9.28	Corporate Property						13%
9.29	Property: Other						5%
9.30	Technology IT and Telecoms						5%
9.31	Valves (IP / MP valves)						20%
9.32	Reduced Depth of Cover >7 bar						20%
9.33	Pipeline Sleeves						20%
9.34	Vehicles & Mobile Plant						5%

		Cost Confidence Level Pre-Efficiency (Cost in £m)					
Submitted Appendix	Project Title	Construction +/- 5%	Detailed Design +/-10%	Conceptual Design +/-20%	Feasibility +/-35%	Pre-Feasibility +/-50%	Weighted Confidence +/-%
9.35	Cathodic Protection		Redacted due to commercial sensitivity				5%
9.36	Pipeline Crossings						10%

Figure 6 also shows the remaining, lower cost, elements of the plan. The majority of these are in the ±5% confidence bracket.

Appendix 6. NARMs reporting

Network Asset Risk Metrics are an evolution from RIIO-1 Network Output Measures and relate to the risk of asset failure (derived from the probabilities and expected consequences of asset failure). Through asset management activities, such as replacement or refurbishment, we can ensure that the risk to customers is maintained within reasonable bounds. The figures above (9 & 10) show that through our investment plan we will reduce monetised risks in mains, services and risers whilst holding other risks broadly flat. This reflects both the outputs from our economic modelling (CBA), safety requirements and the direction we have received from our customers and stakeholders.

Ofgem have stated that 'Network companies will be set clearly defined outputs that require and encourage them to take more long-term view of their network asset risk.' Whilst we welcome the opportunity to work with Ofgem in establishing these outputs, the GDNs have not yet agreed a position with Ofgem on how this output should be calculated or reported.

The risk values in our submission are derived in accordance its most recently approved NOMs Methodology. However, the BP templates require calculations beyond those that the current methodology can support. As such it is difficult to present our NARMs outputs.

The graphic below has been produced from one of our model runs to draw out some of the asset and regional highlights in the plan using a lens of monetised risk benefit delivered during RIIO-2. This is not the output that will be used but allows us to illustrate key concepts. The first thing to note in the graph is the difference in scale of benefits between the different asset groups. Investment in mains and services delivers tens of millions of pounds of risk benefits (it is also the largest area of expenditure in the plan). In contrast investment in LTS and governors creates very little benefit. Investment in these areas in much lower than in mains and services but the low calculated monetised risks are also a feature of these asset models. Considering differences between the regions, repex benefits are much larger in London – this is in part a function of the greater density of people around our network (and therefore the potential to improve safety and interruption risks). There is also a significant number of riser assets in London compared to the other networks. There are greater benefits delivered in our NW pressure reduction assets – both offtakes and governors than in our other regions. This reflects asset condition and performance in this region.