Cadent
Your Gas Network

Appendix 10.08

Uncertainty Mechanism Case

Reinforcements

Cadent's systematic approach to developing uncertainty mechanisms to manage forecast uncertainty

1. Defining our customers' needs

- What is the area?
- Why is it important to customers and stakeholders?
- What insights are shaping our thinking?
  - Customer insights
  - Stakeholder insights
  - Legislative insights
  - BAU operational information
  - Historic insights
  - Wider research

2. Evidencing forecast uncertainty

- What do we know about future workload & costs in this area?
- Why can't expenditure be forecast with sufficient confidence?
  - For example using historical / independent benchmarks
- Why are levels of expenditure outside of network control?
- What customer / network impacts could there be from a forecast error?
- What network behaviours could arise from inclusion within the base plan?
  - What would the customer impact be?

3. Qualitative assessment of the options

- What options other than inclusion in the base plan are available?
- Why are they the options?
- What option(s) are we proposing and why?
- How would the mechanism(s) work? (Implementation, triggers, materiality thresholds etc.)
- What are the customer benefits & drawbacks of the mechanism(s)? (Inc. simplicity)
- Why do the customer benefits outweigh the drawbacks?
- What network behaviours could the mechanism drive?
  - What would the customer impact be?

4. Quantitative assessment of the proposed options

- How do we know our 'input variables' are the best available? (i.e. ranges of workload, costs, trigger points, frequency, probability)
- How are we assuring our modelling results?
- What is the best view of materiality for the area?
- What is the modelled cost volatility for the area?
- How does the proposed mechanism(s) deliver value for money?

5. Quantifying the overall customer impact

- What is the overall customer impact of all areas of forecast uncertainty – with and without mechanisms?
- What does this mean for the balance of forecast risk between customers and networks?
- What does this mean for customer bills?

6. Setting standards that customers love

- Are our proposals, and the associated impacts, easy to understand?
- Can it be demonstrated that they protect customers and investors?
- Is our suite of proposed mechanisms acceptable to customers and stakeholders?

Uncertainty area			
Demand uncertainty	Legislative uncertainty	Cost confidence	Heat Policy

Reinforcements

Proposed by Cadent

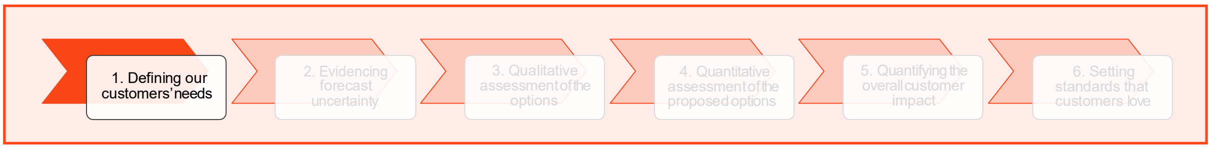
Volume Driver Uncertainty Mechanism

We must respond to changes in demand on our network, to maintain the security of supply that our customers expect and as is set in our Licence. To do this, we undertake reinforcement work to maintain pressure and flow across our network. This work is increasingly difficult to forecast, driven by changes in domestic and industrial customer demand under the energy transition and wide ranges in forecasts for new properties.

The nature of UK growth is hard to predict and will impact our network in different ways depending on local conditions. New housing estates, power generation or industrial processes all increase demand. Although it is possible to model gas demand on a regional scale, it is difficult to assess how this will change locally, how that change will impact on the local network, and what reinforcement work we must undertake.

Enabling reinforcements is a specific component in which, in order to speed up local growth, we install infrastructure before a new development formally begins. We want to facilitate, rather than a block regional growth. As part of our wider proposals on enabling reinforcements, we intend to consider changing the connection methodology to address stakeholder feedback by enabling timely investment. We have extensive support from our regional stakeholders for this proposal.

1. Defining our customers need



1.1. What is the area?

As a company, we are focused on maintaining the security of supply to our customers, including our licence obligations to maintain supply under 1-in-20 year peak demand conditions. This ensures we can meet a level of gas demand which is only expected to be exceeded on average (whether on one or more day) once within 20 years.

Delivering against this obligation requires managing and maintaining pressure across our network. This can require interventions on our network in the form of reinforcement work. Reinforcement increases the capacity of our assets to flow gas, whether through upsizing above or below ground assets, increasing pressure or installing additional assets.

Reinforcements may be required at specific ‘trigger’ sites (specific reinforcement) or may result from a pattern of increasing demand through time which requires our network to expand in response to customer demand for gas (general reinforcement). While we have expertise in undertaking reinforcements, it is becoming increasingly challenging to forecast our future workloads given the uncertainty around customers future demand for gas during the energy transition.

Gas demand continues to evolve, particularly at the local level. General trends of improving energy efficiency amongst businesses and households are reducing demand, whilst new developments – particularly large new housing estates or industrial/commercial properties can create localised peaks in demand which are beyond what the network is designed to deliver. In the case of new developments, we have an obligation under the Gas Act to comply with reasonable requests for new connections, which may require reinforcements at specific 'trigger sites' to be enabled.

1.2. Why is it important?

Our customers expect a secure and reliable supply of gas: therefore, it is important we undertake reinforcement work as demand changes in the future. We want to meet the needs of new customers who want to connect to the gas network. Specifically, in relation to new connections, we do not want to constrain future infrastructure investment, and this requires us to undertake reinforcement on our network to respond to higher consumer demand. This includes providing timely reinforcements for Local Authority approved housing, transport, business or industrial development.

There are also challenges relating to our approach for enabling reinforcements in the future that are important to address. The current regulatory methodology focuses on avoiding the risk of asset stranding; however, this results in capacity being requested by developers as late as possible. Enabling Local Authorities to share this risk would prompt timely investment, drive more efficient development of networks and give Local Authorities incentives to make reasonable forecasts that the networks can use to develop their networks efficiently.

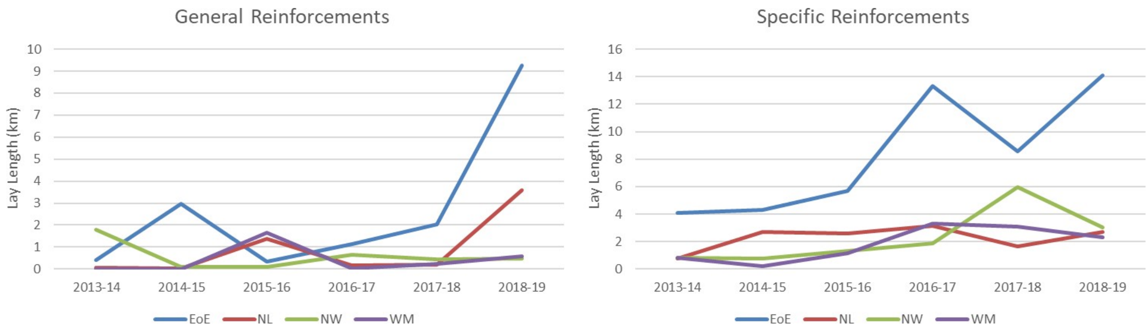
1.3. What insights are shaping our thinking?

RIIO-1 experience to date

As outlined further in Section 2, our experience in RIIO-1 has demonstrated the volatility of reinforcement work and the difficulty we face in generating accurate forecasts. Combined with the increased uncertainty we face in the future over customer demand for gas, this has informed our proposal for an uncertainty mechanism to address this risk.

Figure 1,below, outlines the volumes of general and specific reinforcement work we have undertaken during RIIO-1. As shown, volumes were suppressed towards the beginning of the period, driven by a lack of growth on our networks following the economic downturn. This trend has reversed in recent years as specific reinforcements become more common in response to targeted growth from developers. Higher peak gas demands, as observed during the winter of 2017/18, have also resulted in a greater need for reinforcement than was historically required to provide network resilience.

Figure 1: Volumes of general and specific reinforcement undertaken in RIIO-1



We have also commenced the delivery of several upgrades to above-ground installations (AGI) to maintain capacity in line with our licence conditions. These projects are awaiting construction during the remainder of the RIIO-2 process, and insights from the pre-construction phase have informed our costing approach for RIIO-2. Further details on these assets are provided in Appendix 09.23 Capacity Upgrades above 7 bar reinforcements.

Other insight

As part of our planning process, we have also undertaken work to understand the potential range of future growth across our networks. This included a study of new housing anticipated during RIIO-2, considering known announcements across our network. We conducted a study across 60/370 of our local networks to understand reinforcement and repex requirements as a result of this growth. Table 1, below, summarises the estimated growth, equivalent to approximately 5% on average over RIIO-2 at the Cadent level.

Table 1: Estimated new housing growth (based on a study of 60/370 networks)

New housing growth	East of England		London	North West	West Midlands
	EA	EM			
Average housing demand growth by end of RIIO-2	4.85%	4.11%	4.07%	5.69%	5.26%

In contrast to this study, recent policy discussion has focused on the potential of a gas boiler ban in new homes from 2025. This creates considerable uncertainty on the future volume of new connections and supporting reinforcement work that we may be required to undertake in RIIO-2, especially given the challenges in understanding how housing growth may translate to demand for new connections if such a ban came into force.

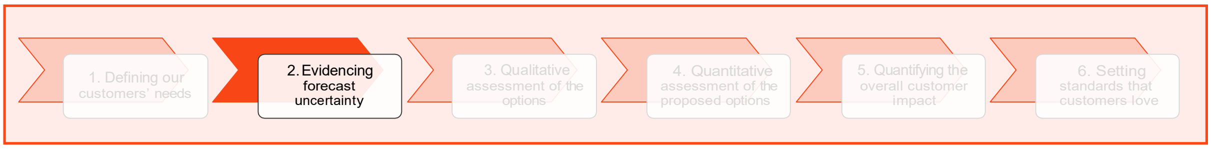
We also have insight shaping the proposals for our Connection Charging Methodology in relation to enabling reinforcements. Feedback from our stakeholders expresses concern that utilities are holding off on network investment to support new developments. We have recognised this risk and the changes that are required to promote the timely reinforcement of our network, to support Local Authority approved infrastructure investment. Specific insight includes:

- At the West Midlands Combined Authority energy capital board on 5 September 2018, they indicated that their thoughts are aligned with the concept of enabling reinforcement.
- Engagement with Greater Lincolnshire Local Enterprise Partnership also highlighted that timely energy network investment can be a barrier to their growth plans.
- In April 2019, we hosted a webinar with a range of Local Authorities and Local Enterprise Partnerships. 15 participants were recorded. We discussed our proposals for overcoming

timing and capacity challenges by developing a framework for Local Authorities to provide security for demand that may arrive within five years of the completion of a new connection. Participants responded positively to the approach and expressed support for continued engagement in the future.

We have a well-established process for responding to new demands and work with a range of public sector and commercial stakeholders to install new capacity. This experience has informed our understanding of the challenges in the process of enabling reinforcement.

2. Evidencing the uncertainty



2.1. What we know about the future

Through network modelling, we have identified several schemes that will require reinforcement. These locations have seen demand increases which compromise our future ability to meet our 1-in-20 obligations. Options have been considered for upsizing various components individually and in combination to identify the most cost-effective means of meeting this requirement. These sites are moving through our feasibility and design process as outlined in Appendix 09.23 Capacity Upgrades above 7 bar reinforcements (AGIs).

As summarised in Section 1.2, we have undertaken a study to better understand future growth requirements. This has involved working with a specialist planning firm to review Local Authority development plans and identify their potential impact on our network. We have run scenarios around these figures to understand a range of possible future positions.

Comparing uncertainty to costs included in our base plan

During RIIO-1, we received a fixed baseline allowance for network reinforcement. As shown in Section 1.2, recent trends in workload demonstrate the difficulty we face in forecasting future workloads. In the early years of the control period we underspent against this allowance, while the opposite was true towards the end.

Our base plan includes expenditure annually based on a volume equivalent to 80% of the minimum general and specific reinforcements observed in each of our networks to date. These volumes are associated with a total cost in our base plan of £11.02m. Further detail is provided in Appendix 09.26 Mains reinforcement below 7 bar.

Table 2: Baseline costs associated with General and Specific Reinforcements

Base costs ***£m, 18/19 prices***	**2021/22**	**2022/23**	**2023/24**	**2024/25**	**2025/26**
East of England	[redacted]				
North London	Redacted due to commercial sensitivity				
North West					
West Midlands					

Our base plan also includes expenditure to address known capacity issues during RIIO-2 at ten AGI sites and to upsize the metering systems at a further two. These volumes are associated with a total cost in our base plan of £32.66m, as outlined in Table 3.

Table 3: Baseline costs associated with PRS Sites, Offtakes and Metering

Base costs *£m, 18/19 prices*	**2021/22**	**2022/23**	**2023/24**	**2024/25**	**2025/26**
East of England					
North London	Redacted due to commercial sensitivity				
North West					
West Midlands					

Our proposal for an uncertainty mechanism provided funding for additional volumes above and beyond those included in our base plan. We remain open to discussion with Ofgem on how best to manage this uncertainty but believe that using an uncertainty mitigation approach protects customers from funding unnecessary costs. As will be discussed further in this document, the mechanism is based on the same unit costs used to develop our base plan proposals. In Section 3, we provide a full evaluation of how the mechanism would work in practice alongside a baseline allowance.

2.2. Why we face forecasting difficulties

Beyond known projects and minimum levels of reinforcements observed to date, there is considerable uncertainty over the volumes of work that will materialise in RIIO-2. While we can develop relevant unit cost estimates for reinforcement works based on historical experience, it is not possible to establish a total cost estimate to include in our base plan. The modelling work we have undertaken in this area to examine these trends has led to a forecast year on year growth in reinforcement activity, but with considerable variability in different scenarios. This uncertainty is driven by:

- **Location of growth** – we do not know where growth will take place. This includes where a factory or micro-power station will be built, or which parts of a strategic land bank will be developed into housing. While Local Authorities produce development plans, there is much variability between what is proposed and what is delivered.
- **Changing customer demand** – we cannot accurately forecast how customer demand will change at the local level, and the impact this will have on our network.
- **Rate of growth** - we do not know the rate of new development. This includes wider economic trends, for example, whether we may enter a recession, or if new incentives for home building will lead to a significant new programme of work.
- **Connections** - we do not know how new developments may connect into a local network and what headroom is in that network to absorb the change.

We are unable to fully control the volume of reinforcement work that we will be required to undertake in RIIO-2, as it is largely consumer-led. We have developed our plan in line with current insight gained through engagement with developers and have proposed the use of an uncertainty mechanism to protect customers from an incorrect forecast.

We will continue to engage with developers to gain a **better view** of changes to demand on our network and to consider any reinforcement this may require. We will also consider the implications that any future Government heat policy decision may have on the role of reinforcement on our network.

2.3. Network impacts and behaviours from including in the base plan

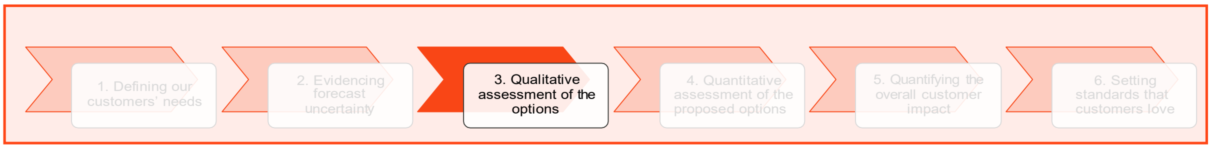
The risk with including all potential volumes and costs for reinforcements in our base plan is that we would be required to rely on an uncertain estimate of future demand growth, and the amount of reinforcement at the local level. This creates a risk that our estimate either under or overpredicts the volume of work we will need to undertake, in an area where we have licence obligations to maintain the resilience of our network.

If we were to include all costs associated with reinforcements in the base plan as part of our RIIO-2 submission, we would be required to rely on uncertain estimates on future growth rates and trends in customer demand, which are inherently hard to predict. Predictability is further reduced by the uncertainty around future heat policy decisions from the Government, which may have implications for the role of gas in new housing and thus the levels of reinforcement required on our network.

There is a **credible risk** that our estimate could underpredict future volumes, creating a financial risk given the requirement to maintain the resilience of our network. We would face an incentive to price risk into base plan estimates for reinforcements, to ensure we were adequately funded in a high-growth scenario.

However, this **creates a risk to customers** as volumes might outturn below an allowance in RIIO-2. We are unable to fully control volumes given the impact of external economic growth and the demand for new connections. This could create an opportunity for windfall gains.

3. Qualitative assessment



3.1. Options for addressing uncertainty

Given the uncertainty in the future workload in RIIO-2 for reinforcements, we have evaluated the appropriateness of different mechanisms that could be used to address this risk:

Table 4: Evaluating options for uncertainty mechanisms

Mechanism Option	Description
Volume driver	This uses existing unit costs information from our RIIO-1 activity. This would effectively address the uncertainty identified in future growth and demand across our networks and ensures we are able to respond to any changes accordingly.
Re-opener mechanism	A re-opener accounts for uncertainty in costs when both the design and requirement in RIIO-2 is unknown. As uncertainty for reinforcement is driven by volumes, this is not applicable. There is also a risk that a re-opener would create friction in the reinforcements process. We have identified stakeholder support to improve the timeliness of enabling reinforcement work that we undertake. However, the re-opener process and evidence required to support this could result in delays to our works.

Mechanism Option	Description
Use it or lose it allowance (PCD)	This would involve a price control deliverable (PCD) as part of our RIIO-2 plan. While this would protect customers from under delivery, it will not address the challenge we face in forecasting a total cost, given the uncertainty in reinforcement volumes. There is a risk that barriers are created if there are insufficient funds to deliver the required reinforcements.

We have also undertaken a qualitative assessment of uncertainty in this area to further understand the need for an uncertainty mechanism for reinforcements

Table 5: Qualitative assessment of risks posed by reinforcements

Volume risk	Unit cost risk	Impact on outputs	Material cost / bill impact
High	**Low**	**High**	**High**

Further detail on our assessment is provided below:

- **Volume risk:** Our work is driven by changes in customer demand, resulting in an uncertain future workload that is out of our control. Controllability is influenced by the consultation we have begun on new arrangements with Local Authorities to share the risk associated with enabling reinforcements.
- **Unit cost risk:** While we have confidence on the underlying cost of laying new pipework, the specific volumes required will influence the total cost.
- **Impact on outputs:** We have licence obligations in relation to reinforcements, and this area of uncertainty also relates to our outputs supporting new connections**.**
- **Material cost / bill impact:** There is uncertainty over the timing of demand from Local Authorities, which cannot be reasonably estimated. This will have implications for the timing of bill impacts for customers. Given our approach to include a minimum volume in our base plan, there is potential for material costs to arise in RIIO-2.

3.2. Our proposed uncertainty mechanism

We are proposing to address uncertainty related to reinforcements using a **volume driver** in RIIO-2, using a unit cost approach to reflect the costs of reinforcing different diameters of pipe or capacity upgrades. In practice, this mechanism would involve agreement on the relevant unit rate to apply to specific volumes of reinforcements with Ofgem.

Operation of the proposed volume driver in practice

- **Form of the trigger**: The need to undertake reinforcement work is largely driven by changes in demand and growth across our network, as summarised in Section 1.1. Below, we summarise specific triggers for different aspects of reinforcement work.

  General reinforcement (below 7 bar): We have an existing process to ensure that work undertaken is required and appropriate. A proposed investment would have to pass through the following steps in order to be triggered:

  - **Step 1:** We use our internal data systems to run reports on asset health. Our systems are updated with relevant management information to align with significant changes observed across our networks. They are also subjected to periodic validation to ensure accuracy. We use our planning models to predict the likelihood of an asset failure over different time horizons.
  - **Step 2:** If a potential failure is identified via our asset health modelling, further investigations are undertaken using real time data to confirm the findings of our asset health models. This includes analysing data to find evidence of low pressure. If our findings validate model predictions, a reinforcement is created.
  - **Step 3:** We also consider the impact of local growth factors and whether this requires reinforcement. We check local planning data provided by local authorities for the relevant network to identify if any growth plans will have implications for a required reinforcement.

  Specific reinforcement (below 7 bar): This work results directly from specific examples of new demand on our network, such as housing development. In these instances, work would be triggered as part of a new connection agreement, and the identification of reinforcement requirements. In Section 1.1 we outlined the steps we are taking to review the charging methodology to provide greater support for enabling reinforcements. In these instances, we propose the uncertainty mechanism should be triggered by the successful agreement on risk-sharing arrangements, which may occur before the formal signing of any connection agreement.

  Capacity upgrades: Finally, in Appendix 09.23 we outline the process for identifying capacity upgrades at PRI sites, or meter-only interventions. On an annual basis, we carry out a supply-demand analysis to understand network resilience. We propose the uncertainty mechanism should be triggered where a specific site is identified as being under capacity through this annual review.

- **Mitigating the likelihood of the trigger**

  General reinforcement: We are required to meet licence conditions to maintain the resilience of our network, which requires reinforcement in response to changing customer demand. The process we have outlined on identifying the need for reinforcement work ensures that the trigger only occurs when the need is justified.

  Specific reinforcement: Given our overall aim to support economic growth, it would not be appropriate for us to actively mitigate the trigger for specific reinforcements. Where possible, we work to signpost developers to existing capacity to minimise the need for specific reinforcement.

  Capacity upgrades: In the short term, we can re-optimise assets identified as being close to breaching capacity requirements to mitigate the need for a trigger. However, we will ultimately need to undertake required work once this is no longer possible to maintain the resilience of our network.

- **Claiming costs through the volume driver:** As part of the RRP process, we would on an annual basis submit data on the actual volumes of reinforcements that we have undertaken. Revenues would be recovered with a year lag, in line with agreed unit rates, allowing time to verify our submitted volumes.

Form of the volume driver:

- **Units of volume:**

  General reinforcement (below 7 bar): We propose volumes are measured in relation to the length of reinforcement work undertaken by diameter (in km). This in line with information already reported on an annual basis through the RRP process. We propose the same approach for **specific reinforcement (below 7 bar)**

  Capacity upgrades: We propose volumes are measured in relation to the number of AGI sites requiring reinforcement of meter interventions. This is in line with information used to construct our baseline funding request**.**

- **Establishing unit costs:** As discussed further in Section 4.0, we have proposed the unit costs within this volume driver align to the unit costs used to develop our baseline plan. This includes a cost per km for general and specific reinforcement and site-specific costs for capacity upgrades. These costs have been developed through analysing our performance today, and our future views of efficiency.

Our analysis of uncertainty for reinforcements focuses on volumes of work associated with general and specific reinforcements below 7 bar. In practice, this mechanism would also cover any required volumes for work above 7 bar, which would be subject to the relevant checks and balances described above. Our base plan does not include any expenditure for this work, and none has been undertaken to date during RIIO-1.

Therefore, it is not possible to develop robust unit cost estimates for inclusion in a driver. Instead, we propose that any such work would be subject to a **competitive tendering process**, with efficient costs recovered therefore through the driver at an efficient rate.

3.3. Evaluating our proposed uncertainty mechanism

A volume driver allows us to protect against the risk of submitting a full base plan allowance that may be calibrated on an incorrect forecast of future growth. As outlined in Section 2.3, if this was to occur, customers may be exposed to the risk that actual volumes in RIIO-2 turn out below our allowed rate. On the other hand, there is a risk to us as a business, especially given our licence conditions with regard to maintaining a gas supply for our customers at specific pressures. A volume driver would make use of agreed unit cost rates to ensure customers only pay for work that is undertaken.

Nevertheless, it is important to fully evaluate the behaviours that our proposed uncertainty mechanism will encourage, to ensure they do not create perverse incentives. Below, we consider positive behaviours that a mechanism should promote.

Table 6: Evaluating incentives created by our proposed uncertainty mechanism

Behaviours and incentives	Evaluation
To minimise costs	Our proposed baseline costs for reinforcements represent our view of achievable and efficient costs in RIIO-2. We have developed our proposed volume driver in line with these costs. A financial incentive remains under the volume driver to identify further efficiencies and to deliver further reinforcement work below these unit costs where possible. This would also benefit customers, by achieving a lower unit cost in the future and sharing through the totex incentive mechanism.
To deliver required work	Reinforcements are largely triggered by external demand. We face licence obligations to maintain the resilience of our network and the security of supply for our customers. A volume driver would not create an incentive to avoid undertaking work. This would have negative reputational and operational impacts on our business. The further checks and balances associated with the triggering of our proposed mechanism also ensure that we do not have an incentive to undertake work beyond an efficient level. For general reinforcements, a series of evidence-based requirements must be satisfied before work is approved. For specific reinforcements, work is externally triggered by the agreement reached with a new connecting party. Finally, for capacity upgrades, assets must be identified as being under capacity before work commences.
To take a whole-systems approach	There may be a concern that a volume driver for reinforcements limits our incentive to consider wider strategic solutions or to take a whole-systems approach to new changes in demand. Financial incentives remain under this mechanism to identify efficiencies against the agreed unit cost rates for reinforcement volumes. This includes any alternative solutions which are more cost-effective than proceeding with traditional reinforcement.
Interactions with expenditure included in our base plan	The costs and volumes included in our base plan are developed across identical categories of reinforcement (objectively determined, in line with RRP requirements), and using the same unit costs associated with our volume driver. Our proposal is for costs incurred to be allocated initially to our allowance. Further reinforcements beyond this value would trigger the application of the volume driver. It would not be possible for us to gain from whether a specific workload is determined as baseline or volume driver activity, as identical unit costs would apply in each scenario.

A potential drawback for customers is that bills may be exposed to any volatility in reinforcement volumes on an annual basis, with revenues recovered with a yearly lag. However, this risk is mitigated by the inclusion of a minimum level of investment in our base plan, creating an element of stability within the overall bill impact of reinforcements.

Interactions with other uncertainty mechanisms in our proposed package

Heat policy

Our proposals for a reinforcements volume driver will interact Ofgem's prescribed re-opener for heat policy in practice. As described in Section 2.1, a key driver of the uncertainty in future volumes is the direction of future Government policy towards the use of gas in new housing.

Any significant policy decisions taken during the RIIO-2 may have significant implications for the volumes of work that we are required to undertake. Recognising this dependency, our proposed approach ensures we can adapt and respond accordingly. For example, if a decision was taken that prevented new gas connections during RIIO-2, this would limit the need for future reinforcement volumes, which would therefore not be requested through the mechanism. Customers' exposure to this is limited by the inclusion of a conservative estimate of new connections in our base plan.

Furthermore, the heat policy re-opener would provide the opportunity for a specific adjustment by Ofgem to our baseline allowances for connections if required following any relevant decisions by the Government.

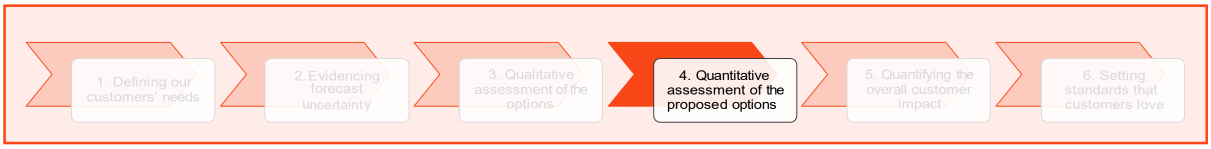
Entry charging and access review

We have also made bespoke proposals for a volume driver relating to enabling reinforcement for new entry gas that is strongly related to our proposals here. While both relate to reinforcement activity, the underling drivers of demand differ.

Our proposals tailored towards entry gas are dependent on the successful conclusion and implementation of a charging and access review to enable a change in commercial regime to support new connections. As outlined in Appendix 10.09, there is uncertainty on the most appropriate way to measure these volumes and associated unit costs, which represent a new activity for us. Our proposed approach includes flexibility to develop a volume driver that effectively supports new entry gas.

We recognise the need to ensure that volumes of work are recorded separately in both cases, to remove any potential for double counting. No costs associated with entry enablement have been included in our base plan and are captured in this distinct mechanism. Given the dependency on a charging and access review, it would not be appropriate to create a single driver for all reinforcement activity.

4. Quantitative assessment



4.1. Inputs for uncertainty modelling

The most likely form of reinforcement intervention we may be required to undertake in RIIO-2 is related to the installation or upsizing of new pipelines. We have a good understanding of costs of different work types, covering typical configurations of pipework and considering factors such as length of scheme, diameter of pipe, surface type and special engineering features. It is the length of pipe, and therefore the volume of workload in RIIO-2, which is uncertain.

The unit costs included in our proposed volume driver for general and specific reinforcements align with those used to develop our base plan proposals. Costs are based on the same unit rates used to develop our base plan proposals. These rates have been identified through analysis of RIIO-1 RRPs. In some instances, unit costs in individual networks or diameter bands appear high relative to other examples. This is driven by low incremental volumes in these cases, driving short lengths and thus high unit costs. Tables 7 and 8 outline these rates for general and specific reinforcements.

Table 7: Unit costs, general reinforcements by diameter (£/m, 18/19 prices)

Pipe diameter (mm)	EoE	NL	NW	WM
Less Equal to 75mm				
Greater than 75mm to 125mm				
Greater than 125mm to 180mm				
Greater than 180mm to 250mm	Redacted due to commercial sensitivity			
Greater than 250mm to 355mm				
Greater than 355mm to 500mm				
Greater than 500mm to 630mm				
Greater than 630mm				

Table 8: Unit costs, specific reinforcements by diameter (£/m, 18/19 prices)

Pipe diameter (mmm)	EoE	NL	NW	WM
Less Equal to 75mm				
Greater than 75mm to 125mm				
Greater than 125mm to 180mm				
Greater than 180mm to 250mm	Redacted due to commercial sensitivity			
Greater than 250mm to 355mm				
Greater than 355mm to 500mm				
Greater than 500mm to 630mm				
Greater than 630mm				

[1] Our reported unit cost in the London network for the 250mm to 355mm diameter is skewed by extremely low workloads, with high project costs. We propose the conditions outlined for unit costs where no length is provided is used in this case for the volume driver.

In cases where no workload has been recorded in RIIO-1, we propose unit costs are estimated in period if any relevant workloads emerge. This could involve a competitive tendering process to identify efficient unit costs.

We have developed a range of high, likely and low-cost scenarios associated with general and specific below 7 bar reinforcement to quantitively assess this uncertainty. These scenarios are based on the following assumptions:

- **Low scenario:** we assume no further work required beyond our base plan allowance. This base plan allowance is developed using 80% of the lowest volumes observed in each of our networks during RIIO-1.
- **Likely scenario:** we assume that volumes are equivalent to 100% of the lowest volumes observed in each of our networks during RIIO-1 on an annual basis.
- **High scenario:** we use a scenario whereby costs and volumes are associated with a growth assumption of between 5-10% (dependent on network) from current levels.

Our uncertainty analysis only models the increment above costs included in our baseline expenditure, as summarised in Section 2.1. These costs are summarised below:

Table 9: Input assumption – incremental costs by scenario for general and specific reinforcement (below 7 bar)

Cadent general and specific reinforcement below 7 bar costs (18/19 prices, £m)	21/22	22/23	23/24	24/25	25/26
High scenario	£19.36	£21.06	£22.76	£24.42	£26.09
Likely scenario	£5.78	£5.82	£5.86	£5.86	£5.87
Low scenario	£0.0	£0.0	£0.0	£0.0	£0.0

We have also included site specific costs estimates for sites that may require capacity upgrades during RIIO-2 based on current analysis. These costs are summarised below and have been derived from a study undertaken by Mott Macdonald. Further information supporting these costs is provided in Appendix 09.23 Capacity Upgrades above 7 bar reinforcements (AGIs). We could apply the same costing principles to any sites emerging in RIIO-2 beyond those identified at the time of submission.

We have also included costs associated with nine sites whereby initial analysis has identified that a meter only capacity upgrade may be required. A single unit cost of **£x.xxm** has been used for this purpose. This cost has been identified within the Mott Macdonald study into capacity upgrades.

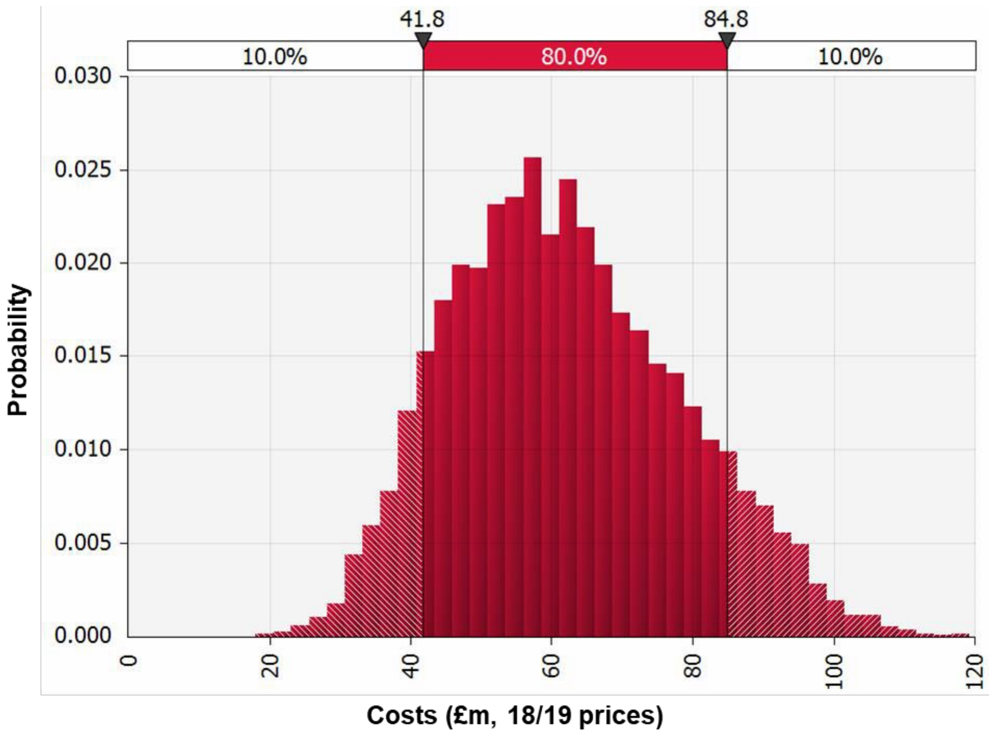
Table 10: Input assumption - Costs for capacity upgrades (£/m, 18/19 prices)

Site name	Network	Site cost
Gentleshaw	WM	
Kingswinford	WM	
Soudley	WM	Redacted due to commercial sensitivity
Ebstree No2	WM	
Euxton	NW	
Rossendale	NW	
Accrington	NW	

4.2. Assessing uncertainty

Using our input data described above, we have undertaken Monte Carlo analysis to understand the range of cost impacts for this area of uncertainty in RIIO-2. This provides a distribution of the potential cost outcomes for reinforcements based on 10,000 iterations. This approach illustrates the 'high' and 'low' scenarios of uncertain costs, alongside the mean cost outcome and associated volatility. Figure 2, below, summarises this distribution, while Table 11 provides a breakdown of this risk by network.

Figure 2: Monte Carlo - Total Cadent RIIO-2 cost risk for reinforcements, no mechanism. Costs, £m 18/19 prices



Minimum	Maximum	Mean	Standard Dev	Iterations
£18.03m	£119.33m	£62.04m	£16.25m	10,000

This analysis illustrates the uncertainty in reinforcement volumes beyond those accounted for in our base plan, and the associated cost risk. Without the introduction of an uncertainty mechanism, there is a considerable risk that actual costs incurred in RIIO-2 may deviate from an initial estimate proposed as a base line allowance.

Table 11: Monte Carlo: Total RIIO-2 cost risk by network for reinforcements, no mechanism. Costs, £m 18/19 prices

Network	Minimum	Maximum	Mean	Standard Dev
East of England	£0.60m	£71.25m	£28.19m	£14.41m
North London	£0.09m	£15.19m	£7.89m	£2.90m
North West	£0.46m	£23.42m	£11.63m	£4.48m
West Midlands	£0.36m	£27.00m	£14.33m	£5.21m

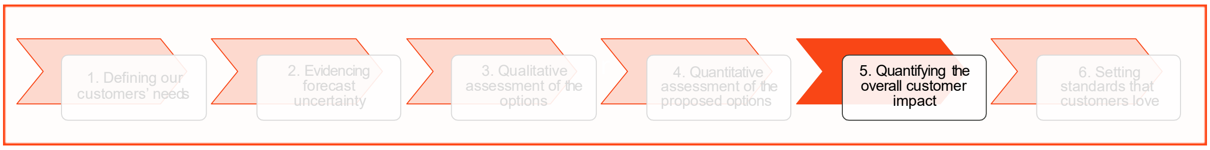
4.3. Impact of our proposed uncertainty mechanism

As we have assumed that income from volume drivers is not subject to a sharing factor, and given that a materiality threshold is not applicable, our modelling implies from a theoretical perspective that the uncertain cost risk outlined above would be fully mitigated using our proposed mechanism.

This **does not imply** that the costs associated with the uncertain volumes are fully mitigated and removed. Instead, the volume driver effectively allows us to collect associated revenues for reinforcement volumes above the amount included in our base plan. This removes a cost risk – that is there are no remaining costs that we are exposed to that cannot be recovered.

In practice, we will remain exposed to residual risk based on how outturn unit costs compare to the rate agreed as part of the mechanism. This places an incentive on us to maintain a focus on cost efficiency when undertaking reinforcements. Customers are also protected as costs are only recoverable for the actual volumes of work we undertake. Given the driver of reinforcement is growth and customer demand, this is partially out of our control. As outlined in Section 2.3, incentives still remain to pursue the most cost-effective solution.

5. Quantifying the customer impact



In Section 5 of Appendix 10.00 Our approach to managing risk and uncertainty, we have analysed the overall customer impact of uncertain costs with and without our proposed package of mechanisms. We have also evaluated how our proposed package recognises the trade-off between sharing exposure of cost risk with our customers. In Chapters 10 and 11 of our Business Plan, we also quantify the impact of our proposed package of uncertainty mechanisms on customer bills in RIIO-2.

We have also quantified the bill impact associated with the reinforcements volume driver individually. Table 12 below summarises the potential bill impact per annum by the end of RIIO-2 for the mean, P10 and P90 costs estimated in our Monte Carlo. As the costs associated with this uncertainty mechanism are categorised as capex, the bill impact is spread over a significantly longer period. For the mean cost impact below, this is equivalent to £0.16 per annum at the Cadent level.

Table 12: RIIO-2 end bill impacts for P10 mean and P90 cost from uncertainty analysis

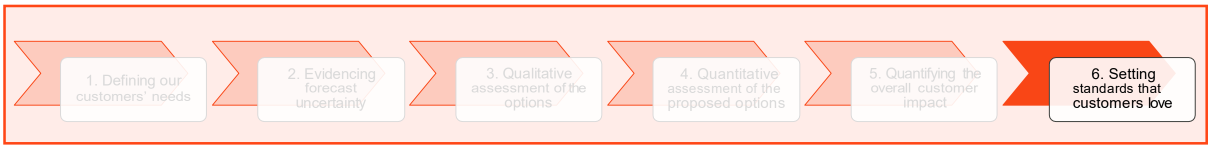
RIIO-2 end bill impact (£, 18/19 prices)	P10	Mean	P90
East of England	£0.19	£0.28	£0.38
London	£0.10	£0.14	£0.19
North West	£0.12	£0.18	£0.24
West Midlands	£0.20	£0.29	£0.40

For the purpose of constructing bill impact estimates, we have focused on the central costs from our Monte Carlo analysis and have not considered the potential timing effects on revenue recovery from the use of a volume driver. In practice, bill impacts would materialise with a lag following a successful claim through the mechanism.

As outlined in Chapter 10 Managing risk and uncertainty, Ofgem's business plan guidance suggests that 'uncertainty mechanisms that highlight risks to consumers of which Ofgem would not otherwise have been aware' is an example that could constitute part of a Consumer Value Proposition (CVP). We discuss our CVP in Section 7.1 of Chapter 7.

The value of a bespoke uncertainty mechanism to customers does not obviously lend itself to be monetised in the same way as some of outputs commitments where we have calculated a social return on investment or have clear willingness to pay data. One way the value could be calculated is to look at the value that might otherwise have needed to be forecast into the base expenditure plan that may not have been subsequently needed if the uncertainty did not arise. For example, you could take consider our likely cost estimate, and multiply this by the totex incentive sharing factor that the customer would be faced with (e.g. 60%). This is not as robust a method as SROI or willingness to pay but provides an indicative estimate. In the case of reinforcements, this is equivalent to approximately **£37.22m in RIIO-2.**

6. Setting the standards



Our proposals for a volume driver are clear and simple for our customers to understand. We will only be able to recover revenue for reinforcements beyond the minimum level anticipated in RIIO-2, which are accounted for in our base plan. Our proposed unit cost rate must be agreed by Ofgem as part of this mechanism to ensure we undertake reinforcements efficiently. We are also unable to control the volume of reinforcements that will be required in the future, as we respond to customer demand. This protects customers and avoids the creation of an incentive to maximise volumes beyond an efficient level. We also have internal checks and balances in place to verify the need for reinforcement works. These proposals have also incorporated challenges we have received from our CEG.

Our evaluation on the implications of including costs for connections in our base plan, as outlined in Section 2.3, and of the incentives associated with our proposed volume driver mechanism demonstrate the benefits of this approach for customers and stakeholders.

Our overall approach to managing risk and uncertainty using uncertainty mechanisms has been tested with customers through our acceptability testing. A full discussion of this engagement is provided in Chapter 10 – it is noted here that customers found our approach to be acceptable, and that we had been thorough in our work to manage cost risk in RIIO-2.