Cadent
Your Gas Network

Appendix 10.00

Our approach to managing risk and uncertainty

Contents

1) Our overall approach

This Appendix supports Chapter 10 of our Business Plan and provides further evidence of the overall approach we have taken to address forecast uncertainty during RIIO-2. It is supplemented by a series of uncertainty mechanism (UM) cases, which justify the mechanisms that we have proposed.

As part of our RIIO-2 planning process, we have identified areas where uncertainty may introduce unacceptable level of risk into our proposals. We need to ensure we strike the right balance of risk with customers in these areas, and to develop a base plan that isn't at risk from the inclusion of low confidence cost items. Areas of uncertainty also create an opportunity for losses or gains for both Cadent and our customers. UMs are a useful tool to protect against this eventuality, and to provide protection against windfall gains.

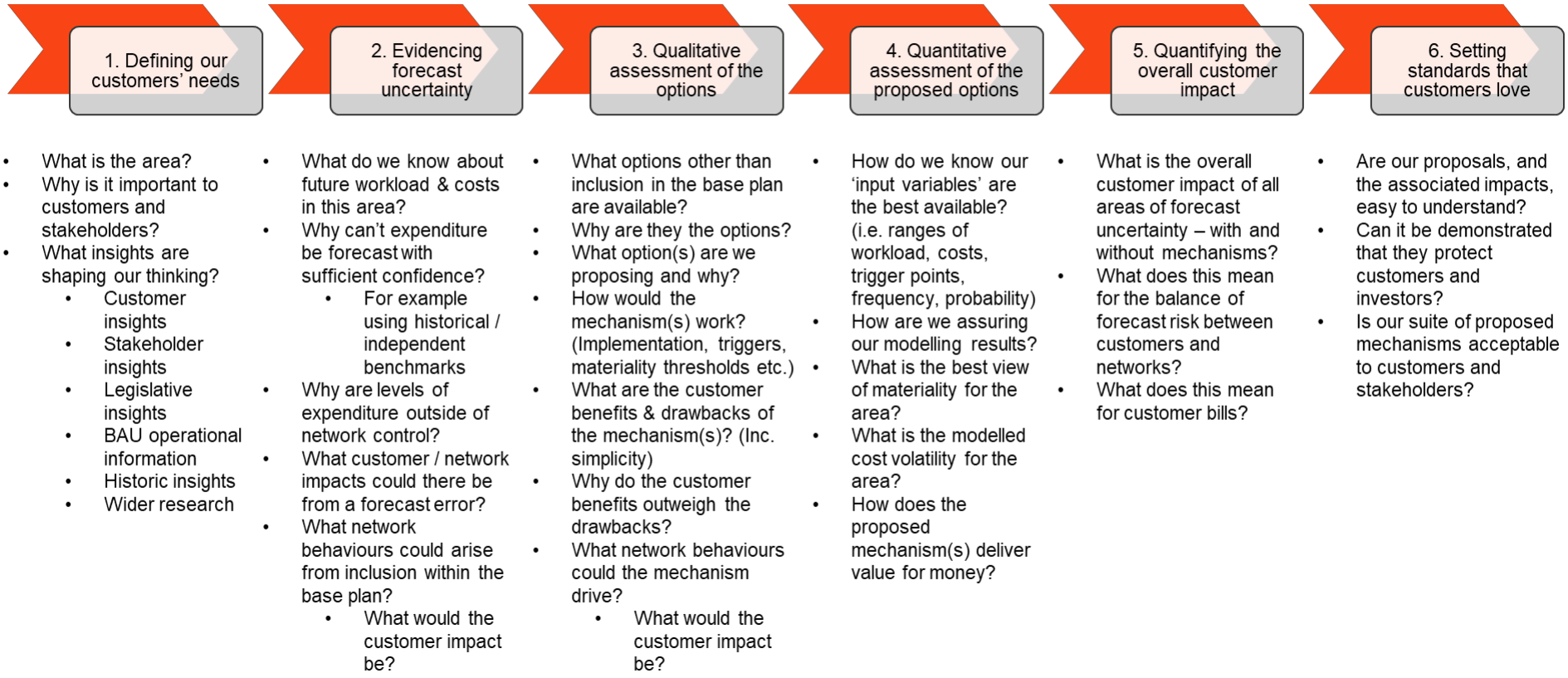
In Table 1 below, we have outlined how we have addressed the Ofgem criteria for UMs in the September 2019 Business Plan Guidance. To understand and manage risk and uncertainty in a thorough and consistent manner, we have developed a systematic approach to evaluate areas where a UM may be appropriate. As summarised in

Figure **1**, this has been developed to reflect Ofgem's guidance, and refined to reflect discussion and challenge from our Customer Engagement Group (CEG).

Table 1: Addressing Ofgem requirements for UMs

What is the issue/risk that the proposed mechanism addresses	In Section 1 and 2 of each of our UM cases, we outline the area of investment where uncertainty has been identified, and the underlying drivers of forecasting difficulty.
Where does the ownership of risk lie in relation to the uncertainty	In Section 2 and 3 of our UM cases, we assess the key drivers of risk in each area, and qualitatively assess how this is currently balanced between Cadent and our customers.
Materiality of issue	In Section 4 of our UM cases, we assess the materiality of each area of uncertainty that has been identified. We undertake Monte Carlo analysis to develop a probability distribution of potential cost impacts over the RIIO-2 period. The cost ranges from this analysis are summarised in Chapter 10 Managing Risk and Uncertainty.
Frequency and probability of issue over the price control period	
What is the proposed mechanism	The specification of each of our proposed mechanisms is discussed in our UM cases, with a justification for why this is the most appropriate regulatory treatment. A summary of our proposals is also presented in Chapter 10 Managing Risk and Uncertainty.
What are the justifications for the mechanism	
Can the drawbacks be reduced?	In Section 3 of each of our UM cases, we have assessed the behaviours that each mechanism may encourage. This has included identifying potential drawbacks and proposing mitigation strategies where appropriate. We conclude after undertaking qualitative and quantitative assessments of each risk on why a mechanism is appropriate.
Explanation of how on balance, the mechanism delivers value for money while protecting the ability to finance efficient delivery	
Treatment in BPDTs	Each mechanism is included in BPDT 5.18, where full description of how costs have been treated is provided

Figure 1: Our overall approach to managing uncertainty and risk



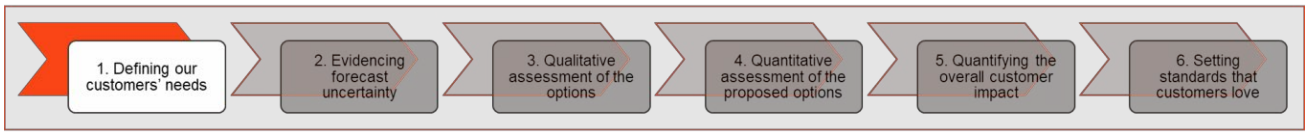
Our individual UM cases apply this approach in each area. Figure 2 below summarise the key issues we have sought to address at each stage of the process.

Figure 2: Our key considerations when evaluating uncertainty and risk

Step one - Defining our customers' needs	We want to understand the areas of uncertainty that we need to address. This includes focusing on areas that are important to our customers/stakeholders, and to consider insights that have a bearing on the need for a UM. Ultimately, we want to cover areas of work that our customers or stakeholders need us to deliver.
Step two - Evidencing forecast uncertainty	We want to understand the source of uncertainty, and the factors that prevent us developing a forecast with enough confidence to include in our base plan. We also want to consider what would happen if we did not adopt a UM, including the implications for customers and the incentives we would face.
Step 3 - Qualitative assessment of the options	We want to evaluate the merits of different types of UMs. We want to be aware of any potential drawbacks associated with the mechanism, and how we can reduce these proactively. We also want to understand the impact of UMs on our network, customers, and company behaviours.
Step 4 - Quantitative assessment of the options	We want to understand the potential materiality and volatility of costs in each area. This includes using appropriate inputs to develop our view and considering the likelihood and frequency of the risk.
Step 5 - Quantifying the overall customer impact	We want to understand the overall impact to our customers of our proposed package. This includes reviewing the risk associated with our complete package of proposed UMs, understanding where the balance sits between Cadent and our Customers. We also want to consider the potential bill impact implied by our analysis.
Step 6 - Setting standards that customers love	Finally, we want to ensure that customers and stakeholders understand our proposed mechanisms, and that they find the overall package acceptable.

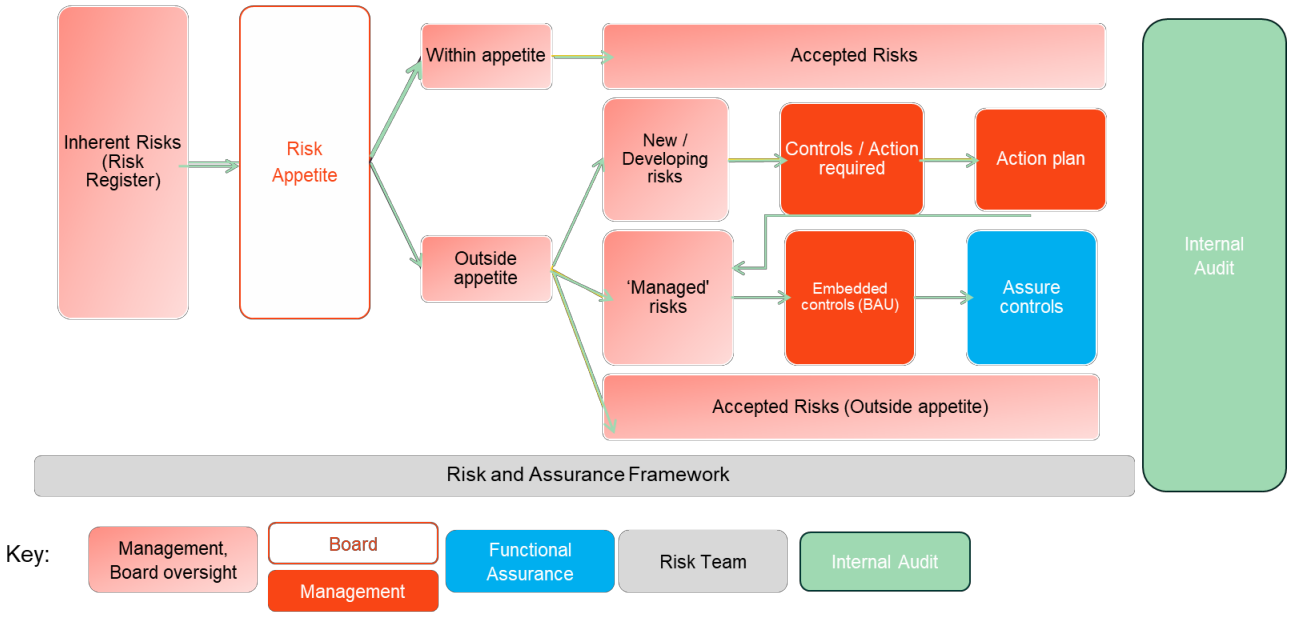
The remainder of this Appendix provides further detail of each component within our systematic approach. Specific details for individual areas of uncertainty are outlined in our UM cases (Appendices 10.01-10.15).

2) Step 1 - Our approach to defining our customers' needs and understanding risks and uncertainties



Our first step is to identify potential risks and uncertainties and define our customers' needs in relation to these risks. We combined a top-down and bottom-up identification of risk areas. Our top-down assessment drew input from our integrated risk and assurance framework. Our overall approach to risk management has been developed in line with the principles of ISO 31000, which is illustrated in the Figure 3 below.

Figure 3: Our integrated risk and assurance framework



Our two-way assessment ensures we take an informed view of the potential risks we must mitigate:

- **Top Down:** Our top down risk assessment draws input from our integrated risk and assurance framework (Figure 3). This approach distinguishes between risks we can manage as a business (due to our understanding and ability to mitigate through business as usual (BAU) activities) and new and developing risks (which largely arise due to external factors we have limited control over). We used the output of this assessment to consider if risks identified centrally were most appropriately addressed through a UM in RIIO-2.
- **Bottom Up:** We supplemented this approach with a bottom up assessment, making use of the experience and expertise of subject matter experts across our business. This approach supplemented our top down assessment and ensures we can fully reflect risks across our business. In the development of our RIIO-2 plan, this involved engaging directly with individual

business leads, understanding areas where they face uncertainty, and working to ensure they were adequately mitigated by our package of proposals. We also validated our final proposals with our Executive Committee.

One top-down approach we have taken is to undertake a PEST assessment with our Customer Engagement Group, as illustrated in Figure 4 below. This approach has added a further perspective to our overall risk approach.

Figure 4: Results from CEG PEST assessment

Political

- Brexit
- Nationalisation
- A labour government
- Hung parliament
- UK Carbon targets and Paris agreement
- Future ownership models of networks
- Greater devolution and divergence of policy
- Coordination direction policy of BEIS and Ofgem
- Geopolitical events
- Political debates around energy costs
- Financial markets lose interest or confidence in regulated infrastructure
- Supplier hub reform
- Security of supply and exposure from Europe/Russia
- Fracking
- Cadent investors only focused on recovering its investment

Social

- Aging population
- Increase in private renting
- Increasing energy costs and how this affects fuel poverty
- Increase in single pensioner households
- Cyber security and terrorism
- Rise in customer expectations
- Culture of the workforce / future skills
- Uncertainty on future gas users
- Rise of localism and customers who want control
- Wider engagement with more of the customer base
- Lack of connection between Cadent and customers when compared to gas suppliers

Economic / Environment

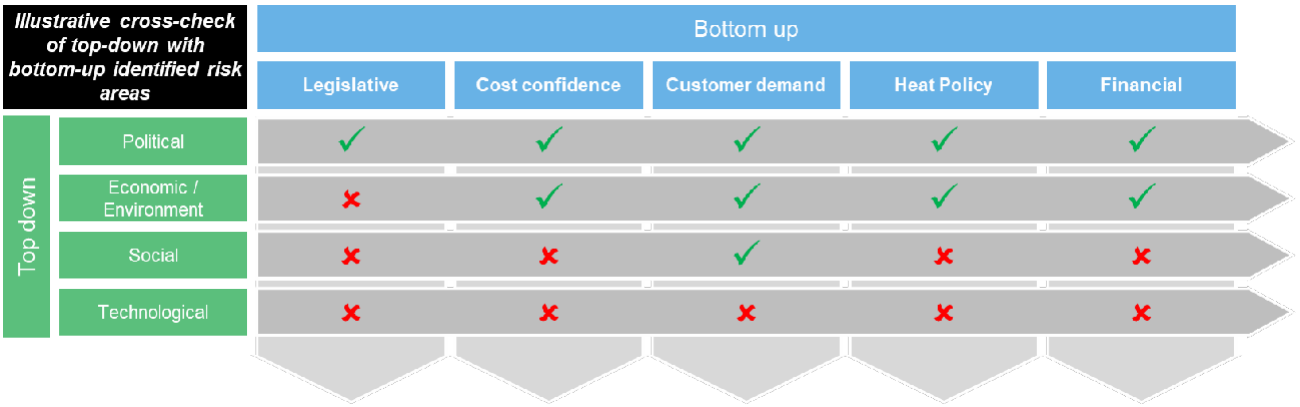
- Unpredictable and extreme weather
- Economical changes
- Use of network for other purposes
- Interest in exchange rate inflation
- Decarbonisation
- If there may be heat, hydrogen, electric heating areas in the future, what does it mean for the iron replacement scheme?
- Price of energy to the consumer
- Customer demand for new connections
- Service provision / focus on maintaining amenities of gas
- Stagnating wages

Technological

- Repurposing the gas network
- Smart meter data interpretation
- Changes of gas mix and impact upon homes and industry
- Smart management of demand fluctuations
- Doing enough innovation to meet long term needs
- Role of energy and gas in industrial strategy
- New / downsized smart boilers
- Electric vehicle uptake / heat pump uptake
- Digitisation / social media / smart technology

Following this exercise, we have undertaken a **cross-check** between the top-down and bottom-up approaches. This recognises that the business impacts of many of the areas identified through the top-down approach relate to items identified through the bottom up approach. For example, the potential business cost impacts from Brexit include the impact on: RPEs, the cost of debt, cost of equity and growth (connections and reinforcement); these are all areas of uncertainty identified through our bottom-up approach. **Error! Reference source not found.** below provides an example of this cross-check.

Figure 5: Illustrative cross-check between top-down and bottom-up areas of uncertainty



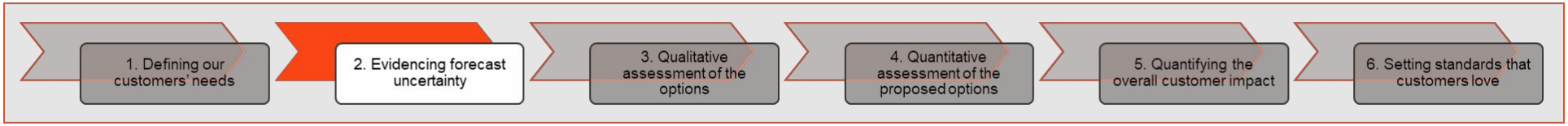
We have applied a systematic approach to classify risks identified, and determined which of the following mitigation strategies is most appropriate:

- **Monitor risk and manage internally:** cases where a risk has a limited likelihood of occurring and/or isn't expected to have a material impact on our business.
- **Manage through the base plan:** cases where we have identified a material and/or likely risk and have a good understanding of actions required to mitigate it (and the associated cost of doing so).
- **Manage through UMs:** cases where we have identified a likely and/or material risk, but face difficulty in forecasting the cost or volume of work, we have evaluated the appropriateness of using a UM to mitigate against this.

As part of our top down and bottom up assessments, we have analysed the drivers of potential uncertainty and sought to understand the impact of each risk identified. Further details on this analysis for our proposed set of UMs are outlined in Section 3 of this Appendix. The key factors identified as driving these uncertainties include:

- **Demand uncertainty:** There is uncertainty over demand growth on the gas networks. This creates a range of possible outcomes for the volume of work we will be required to undertake in RIIO-2 in some areas.
- **Legislative changes:** There is uncertainty in some areas over future legislation or policy changes, which may have a significant impact on the activities we need to undertake in RIIO-2. This could be due to a change in the volume or scope of work we are required to undertake to meet changing requirements.
- **Cost confidence:** There is uncertainty in some areas on the cost forecasts we can establish. We believe there are areas of low confidence costs, driven by information constraints or external cost drivers. In these cases, there is a risk to customers of windfall gains from including costs in the base plan.
- **Heat Policy:** There is uncertainty over the timing and form of future key heat policy decisions, which may have significant impacts on our activities and cost base.
- **Financial impact:** Finally, wider economic conditions may impact key financial parameters that the base plan is calibrated against, and thus create risks to revenue recovery.

3) Step 2 - Evidencing forecast uncertainty



A key criterion for identifying the need for a UM is evidence that it isn't possible to develop a confident cost estimate for inclusion in our base plan. In our UM cases, we outline the factors driving each area of uncertainty, and consider the implications of including an allowance within the base plan. In Table 2 to Table 5 below, we provide a summary of this evaluation for each of our proposed bespoke UMs.

Table 2: Evidencing forecast uncertainty for our proposed UMs to address demand uncertainty

UM	Customer need	Driver of uncertainty	Reasons for excluding from base plan
Connections	Customers expect to be able to connect to our network when they need to. We are required to undertake new connections for both domestic (including new and existing housing) and industrial customers upon request, however the charging arrangements differ between the groups.	Connection volumes are driven by external demand from customers, which in turn is driven by a range of variables including macroeconomic conditions and government policy towards future heat sources. We can develop forecasts based on estimates of future growth, however there is a risk that these assumptions won't correspond to future changes.	Volume risk drives uncertainty in constructing a total cost estimate to include in the base plan. Instead, we have included the minimum volume of connections undertaken in RIIO-1 in our base plan on our annual basis. Expenditure beyond this point is highly dependent on external growth factors, which can display volatility on an annual basis. If we were to include a full allowance for connections in our base plan, there is a risk that this will differ from actual required expenditure if actual growth volumes differ from our assumptions, creating opportunity for losses or windfall gains to customers and Cadent.

UM	Customer need	Driver of uncertainty	Reasons for excluding from base plan
Diversions	Customers and stakeholders require us to undertake diversions works to maintain the safe operation of our network, and to ensure we can continue to access the network following third-party development. Our requirements to undertake such work is driven by responsibilities under the Gas Pipeline Safety Regulations to be able to actively access and maintain our pipes and thereby minimise health and safety risks and interruptions to supply caused by gas escapes and/or pipes collapsing.	There is uncertainty in the volume of work we will be required to undertake in RIIO-2. Diversions are triggered by customer demand, which may materialise in period without forewarning. Developer's plans, and therefore requirements, are susceptible to change at short notice. There is also uncertainty over the individual costs of work, especially in relation to non-chargeable diversions. This is compounded by uncertainty in land access rights and associated legal costs.	Both volume and unit cost risk drive uncertainty in constructing a total cost estimate to include in the base plan. Instead, we have included 80% of the minimum volumes of diversions undertaken in RIIO-1 in our base plan on an annual basis. Expenditure beyond this point is highly dependent on growth in customer demand. If we were to include a full allowance for diversions in our base plan, there is a risk that this will differ from actual required expenditure if actual growth volumes differ from our assumptions, creating opportunity for losses or windfall gains to customers and Cadent.
Reinforcements	To provide and maintain the security of supply that our customers expect, and is set in our Licence, we must respond to changes in demand on our network. To do this, we undertake reinforcement work to maintain pressure and flow across our network. This increases the capacity of our assets to flow gas, whether through upsizing above or below ground assets, increasing pressure or installing additional assets.	Reinforcement work is driven by responses to changes in customer demand and network growth, both of which are influenced by external factors outside of our control. This includes macroeconomic conditions and government policy decisions influencing infrastructure. We can develop forecasts based on estimates of future growth, however there is a risk that these assumptions won't correspond to future changes.	Volume risk drives uncertainty in constructing a total cost estimate to include in the base plan. Instead, we have included 80% of minimum level of reinforcement undertaken in RIIO-2. Expenditure beyond this point is dependent on external growth factors, which can be volatile. If we were to include a full allowance for diversions in our base plan, there is a risk that this will differ from actual required expenditure if actual growth volumes differ from our assumptions, creating opportunity for losses or windfall gains to customers and Cadent

Table 3: Evidencing forecast uncertainty for our proposed UMs to address legislative uncertainty

UM	Customer need	Driver of uncertainty	Reasons for excluding from base plan
MOBs	We are focused on the safety of our customers and are regulated by the standards set by the Health and Safety Executive (HSE) and other Government agencies. The Hackitt Review, in response to the Grenfell Tower tragedy, has increased focus on safety standards for Multiple Occupancy Buildings (MOBs). Alongside new requirements that may emerge from the Hackitt Review, society's attitude to safety risk continues to evolve, and legislation and HSE enforcement approaches respond.	We are unable to control the conclusions that independent surveys and reviews will reach in relation to high rise MOBs. Our engagement to date suggests that a potential outcome is a movement towards annual building surveys, rather than the existing 10-year cycle. However, there is uncertainty over which buildings this may apply too. There is also potential for broader conclusions to be drawn by the HSE towards high rise MOBs, requiring fundamental change. This could involve investment in alternative heat sources.	It isn't possible for us to fully consider the impact of existing surveys and independent reviews until these processes have reached a conclusion. There may also be legislation that arises from these processes which could impact our workloads. If we were to include costs in our base plan at present, they may be based on assumed changes that don't align with future movements in policy. This creates an opportunity for losses or windfall gains to Cadent
Traffic collision protection	We take measures to prevent damage to operational assets or possible injury to Cadent employees / members of the public as part of our duties under the Health and Safety Work Act 1974. Recent examples of vehicle collisions with governor assets (where a vehicle left the road and struck a governor asset), and subsequent interventions by the HSE, have demonstrated the potential for requirements to address specific sites.	We are unable to control the volume of assets that the HSE may mandate additional protection for against traffic collisions. We can understand the unit cost of this work and have undertaken survey work to understand the potential level of risk at present. However, the volume of work we will be required to undertake will be driven by future decisions from the HSE.	Volume risk, which is influenced by a policy decision from our regulators, drives uncertainty in constructing a total cost estimate to include in the base plan. If we were to include costs in our base plan at present, they may be based on assumed changes to our workload that don't align with future movements in policy. This creates an opportunity for losses or windfall gains to customers and Cadent

Table 4: Evidencing forecast uncertainty for our proposed UMs to address cost confidence uncertainty

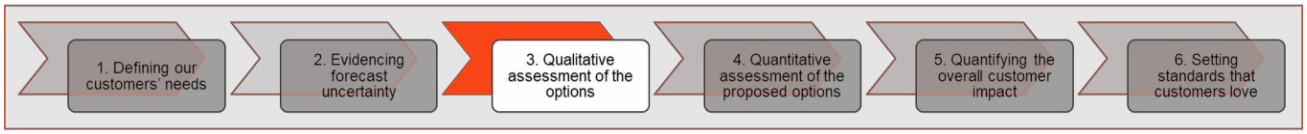
UM	Customer need	Driver of uncertainty	Reasons for excluding from base plan
Pipes Above Safety Threshold (PAST)	We are focused on maintaining the security of supply for our customers and doing so safely. A key part of this is monitoring the performance of our pipe network and identifying pipes that need to be replaced to ensure compliance with Pipeline Safety Regulations (PSR, 1996). As a pipeline operator we have duties under the PSR to ensure that our pipelines are constructed to be sound and fit for purpose, that they are maintained in an efficient state. This includes pipes beyond those covered by the iron mains replacement programme.	Whilst we have good knowledge of existing unit costs to undertake mains replacement work, there is uncertainty on the total number of pipes we will need to replace, and the method of replacement. It is challenging to accurately model which individual pipes will fail and require replacement. This creates uncertainty on actual workload we will face, and the costs incurred at each site.	Volume risk drives uncertainty in constructing a total cost estimate to include in the base plan. Different volumes of work also have specific unit costs associated with them, which differs by region and pipe diameter. If we were to include a baseline allowance, this may overcompensate for the type of number of individual pipes that breach a risk criterion. There is also the potential for the opposite to occur, creating a financial risk in an area of safety driven activity. This creates an opportunity for losses or windfall gains to customers and Cadent
Lowestoft project	Following the collapse of the quay at Lowestoft Harbour in 2012, the existing intermediate pressure gas pipeline in the quay had to be abandoned. A temporary solution was introduced, which has remained in place for longer than intended due to challenges implementing a long-term solution. The High-Density Polyethylene pipes remain in place, while additional issues with the surrounding network have materialised.	There is uncertainty over the most appropriate option for addressing the risks identified in Lowestoft tunnel. This will be addressed in the future as we continue to undertake feasibility studies to identify the most appropriate solution	Cost risk drives uncertainty in constructing a total cost estimate to include in the base plan. As we continue to evaluate the most appropriate option for addressing the risks identified at Lowestoft tunnel, it isn't possible to include the specific costed option in our base plan until such feasibility studies have concluded. If we were to include a specific project cost in our base plan now, this may not align with the most appropriate option we identify in the future as we continue to consider analysis. This creates an opportunity for losses or windfall gains to customers and Cadent.

UM	Customer need	Driver of uncertainty	Reasons for excluding from base plan
High Pressure valves	To ensure we remain compliant with Pipeline Safety Regulations (PSR 1996) we need to maintain the condition and operability of valves on our high-pressure network. These critical valves were installed when the pipelines were originally constructed, up to 40 years ago. Our inspection program during RIIO-1 has raised several issues around valve operability, in particular that a number of valves have been buried as a result of roadworks. We are beginning a programme of more detailed survey work including excavation of buried assets to better understand these issues.	The volume and nature of intervention is unknown, as several our assets have been buried by third party work in recent years and although we are beginning a programme to re excavate them the condition is unknown.	Volume risk drives uncertainty in constructing a total cost estimate to include in the base plan. A figure included in the base plan would be uncertain due to the large number of assumptions required – volumes, activity and cost. A material investment is likely to be required. We must ensure that identified work is completed to comply with pipeline safety regulations. Any costs included in the base plan result in a risk that future workloads may deviate from our assumptions. This creates an opportunity for losses or windfall gains to Cadent.

Table 5: Evidencing forecast uncertainty for our proposed UMs to address heat policy uncertainty

UM	Customer need	Driver of uncertainty	Reasons for excluding from base plan
Entry charging and access review	Current entry arrangements mean customers only pursue realistic connections where there is existing capacity. Otherwise, the cost of investment to provide entry capacity is recovered from a single 'triggering party'. Investment cases for biomethane production can be undermined further as in some parts of the network there is very low consumer demand during the summer. This means there is insufficient available year-round capacity to accept the flow rates that would be required to sustain the investment. This has led to some projects accepting seasonal variable capacity connections, which at times are below their full commercial capability.	We are proposing an entry charging and access review that would enable the socialisation of costs associated enabling the entry of greener gas. There is uncertainty on the outcome of this process, and whether a change will be achieved that supports an increase in entry gas volumes. We can estimate the potential volumes of new entry gas based on centrally agreed future gas scenarios (which display as a potential range rather than specific estimate), and the potential cost associated with this. However, the specific solutions will depend on the outcome of our charging review.	We require the successful completion of our review before specific costs could be considered for this area. Once this is undertaken, volume risk will drive uncertainty in costs. It would not be appropriate to include expenditure in our base plan that is dependent on further policy developments to enable investment. If this was to occur, there is a risk that customers would fund work that hasn't been enabled through a change to the charging regime.

4) Step 3 - Qualitative assessment of options



For each of our proposed UMs, we have assessed:

- **Appropriate regulatory mechanisms:** We have assessed the appropriateness of mechanisms including incentives, reopeners, volume drivers and use it or lose it allowances for each area of uncertainty. This focused on analysing the drivers of each uncertainty, and the potential behaviours that would be incentivised under each mechanism.
- **Appropriate customer protection:** We have reflected the extent to which the areas of uncertainty we have identified as being appropriate for treatment align with Ofgem's guidance – that UMs are designed to protect customers by reducing risk that cannot be managed by the business. We considered the risks associated with volumes and unit costs, the impact of the risk on our outputs, and the materiality of each area.

These assessments have informed of individual proposals outlined in our uncertainty cases. Table 6 below summarises the suite of mechanisms included in our proposals.

Table 6: Our proposed range of UMs

Mechanism name	Volume Driver	Reopener
Mechanisms proposed by Ofgem in the Sector Specific Methodology Decision		
Repex - Tier 2A iron mains	✓	
Repex – HSE policy changes		✓
Physical security		✓
Heat Policy (including FPNES)		✓
Cyber resilience		✓
Mechanisms invited by Ofgem in the Sector Specific Methodology Decision		
Smart meter rollout costs	✓	
Specified street works (lane rental)		✓
Bespoke mechanisms proposed by Cadent		
Pipes Above Safety Threshold (PAST)	✓	
Reinforcements	✓	
Entry charging and access regime change	**Reopener to trigger volume driver**	
Obligations with respect to MOBs		✓
Connections	✓	
Diversions		✓
Lowestoft project		✓
Traffic collision protection	✓	
High pressure valves	✓	

Full details of our qualitative assessments are provided in individual UM cases and summarised below in Table 7. These assessments have been undertaken on a qualitative basis to inform the appropriate type of mechanism to address individual areas of uncertainty. We have evaluated the following key components of each risk:

- **Volume risk** – how variable is the workload expected to be in RIIO-2?
- **Unit cost risk** – how variable are the unit costs of undertaking work in this area?
- **Impact on outputs** – are other areas of our Business Plan impacted by this uncertainty?
- **Material cost** – is this area expected to require significant investment in RIIO-2, or lead to material bill impacts?

Table 7: Qualitative assessment summary of uncertainty areas

Area of uncertainty	Volume risk	Unit cost risk	Impact on outputs	Material cost
Specified street works (lane rental)	**High**	**Medium**	**Medium**	**Medium**
MOBs	**High**	**High**	**High**	**High**
Repex - HSE policy changes	**High**	**Low**	**Medium**	**High**
Cyber resilience	**High**	**High**	**Medium**	**Medium**
Physical security	**High**	**Medium**	**Low**	**Medium**
Heat Policy	**High**	**High**	**High**	**High**
Diversions	**High**	**Medium**	**Medium**	**Medium**
Lowestoft	**Low**	**High**	**Medium**	**Medium**
Smart meter rollout costs	**Medium**	**High**	**Low**	**Medium**
Repex - Tier 2a iron mains	**High**	**Low**	**Low**	**Medium**
Reinforcements	**High**	**Low**	**High**	**High**
PAST	**High**	**Low**	**Low**	**High**
Entry charging and access review	**High**	**Medium**	**Low**	**High**
Connections	**High**	**Low**	**Medium**	**High**
Traffic collision protection	**Medium**	**Low**	**Low**	**Medium**
High pressure valves	**High**	**Medium**	**Medium**	**Medium**

Finally, for each UM we have also assessed the positive behaviours that each should promote, and the incentives they may create. This includes:

- **Incentives to minimise costs**: Ensuring that compared to a base plan allowance, the proposed UM still maintains a focus on delivering work as efficiently as possible.
- **Incentives to deliver required work**: Ensuring that an incentive remains to undertake required work compared to using a base plan allowance. Also ensuring that the mechanism doesn't encourage a workload above the efficient level that would be used to develop a base plan allowance.
- **Incentives to take a whole systems approach or to identify strategic solutions**: Mechanisms should not dilute the incentive to use innovative solutions to deliver workloads. This includes where applicable actions such as no build solutions.
- **Interaction with base plan allowances**: We have considered the interaction between our proposed UMs and funding included in the base plan to ensure no perverse incentives are created which may lead to customer harm.

5) Step 4 - Quantitative assessment of options

For the areas of uncertainty that we have identified as being appropriate to address through an UM, we have undertaken analysis to understand the materiality of the issues. This includes our view of both the frequency and probability of the issue occurring across RIIO-2. Further details on how key variables would be calibrated in practice are provided in UM cases.

For this purpose, we have undertaken Monte Carlo analysis, which allows use to run simulations and consider the probability of different outcomes occurring. This evaluates multiple areas of uncertainty simultaneously and considers the overall impact of UMs on our proposals. This technique allows us to make use of the information that we do possess (but isn't precise enough to develop a confident baseline allowance) to consider the overall range of cost outcomes that may arise in RIIO-2.

The Monte Carlo analysis we have undertaken is specific to individual areas of uncertainty we have identified, with full details on input assumptions and outputs outlined in individual UM cases. However, the logic applied is broadly similar for the two different categories of mechanisms we consider: volume drivers and reopeners. Below, we summarise the approach to our analysis in each case.

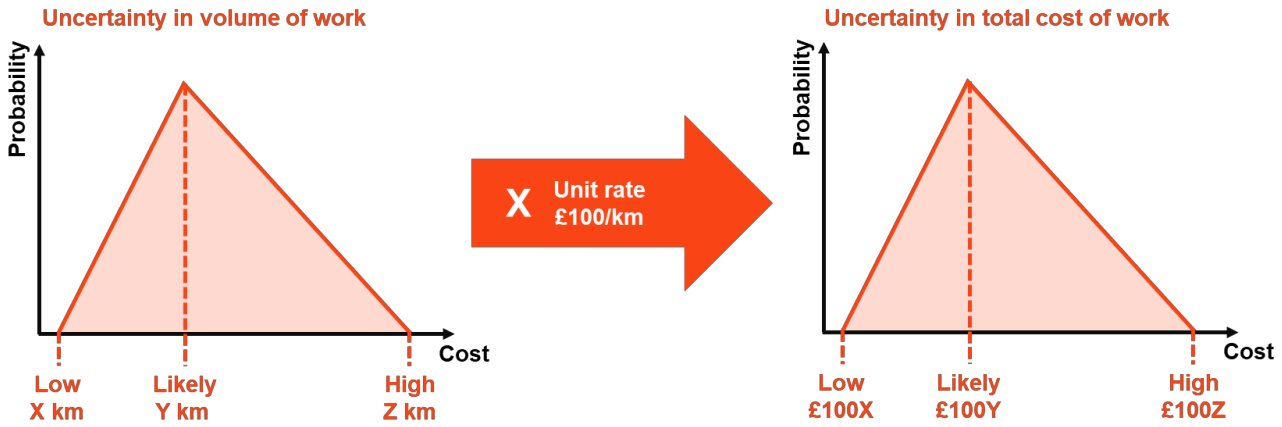
Volume drivers

In areas where our qualitative assessment identified a volume driver as the most appropriate way to manage the uncertainty, we have used input assumptions for the following variables:

- **Unit cost(s):** In most of these cases, we have used an estimate of relevant unit costs, based on our best estimate at present given the information we have available.
- **Volumes of work:** We have assumed a range of potential volumes that could materialise.

Figure 6 below summarises how both inputs are used. Firstly, we define a distribution for volumes of work, using a triangular distribution[1]. We use business expertise to make assumptions on the minimum, most likely and maximum volume scenarios and fit a distribution amongst these values. The relative position of the likely assumption within this range determines whether we expect a higher or lower value on average. For example, in the example illustrated in Figure 6 , our assumptions reflect business expectations that a volume towards the lower end of the range is expected on average.

Figure 6: Inputs for modelling cost uncertainty for volume drivers



Once a distribution of volumes has been constructed, this is combined with our assumptions of unit cost(s) to produce a distribution of total costs. In the illustrative example above, a single unit cost of £100 applies to each unit of work. In practice, several of our proposed volume drivers involve specific unit costs for different volumes of work in each area, however the method described above is still applicable. A total cost distribution is produced by combining all relevant components of this calculation together.

Re-openers

In areas where our qualitative assessment identified a reopener as the most appropriate way to manage the uncertainty, we have used input assumptions for the following variables:

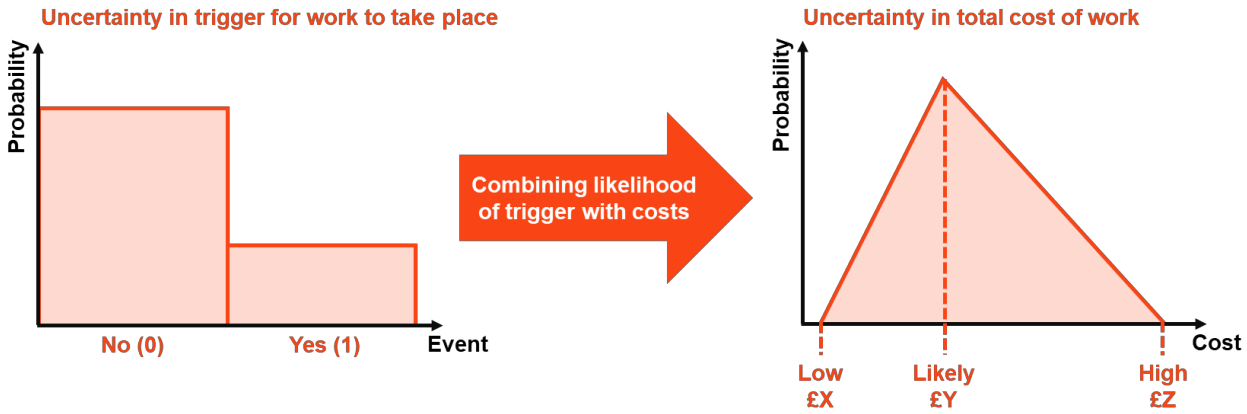
- **Likelihood of event:** In most of these cases, an external trigger will determine whether any costs will be incurred. This for example could be a policy decision by government which would lead to additional work. In these cases, we have assumed the likelihood of the trigger taking place, making best use of insight and information we currently have.
- **Total cost of work:** We have also made assumptions on the potential range of total cost that could be incurred in RIIO-2. In some instances, this is based on calculations broken down by both uncertain volumes and unit costs. In others, for example specific works where a unit cost isn't applicable, a range of total cost estimates are assumed.

Figure 7 below summarises how both inputs are used. Firstly, where applicable, we define a Bernoulli distribution for the likelihood of the trigger event taking place. We then construct a total cost distribution[2], using business expertise to make assumptions on the minimum, most likely and

[1] The triangular distribution is a common approach used in Monte Carlo analysis. This makes use of insight on the range of values a variable may take, and the central estimate that is anticipated. As there is uncertainty of the underlying distribution, this approach forms a continuous distribution between values that can be estimated.
[2] As described above, in some instances our total cost distribution is constructed by making singular assumptions on minimum, most likely and maximum total costs. Where more granular data is available, these are used to calculate the total cost, with uncertainty accounted for in individual components of this calculation. Please see our uncertainty mechanism case on street works for a worked example.

maximum volume cost scenarios. This involves the application of a triangular distribution as previously described, where the relative position of our likely cost estimate reflects our view on where we expect costs to fall within this range on average.

Figure 7: Our inputs for modelling cost uncertainty for reopeners



From this position, we have applied the totex incentive mechanism (TIM) incentive rate, assumed at 40%, to model and log up costs. This value is then compared against a materiality threshold, of 1% of annual revenues, to consider if this is breached after the application of TIM.

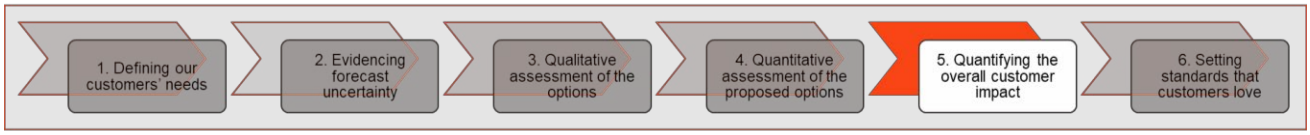
From this position, Monte Carlo analysis is conducted using 10,000 iterations to produce a distribution of total costs that may be incurred in RIIO-2. This combines the likelihood of costs being incurred with a simulation on the total cost outcome.

Results of our uncertainty analysis

We have applied Monte Carlo analysis in line with this methodology for each of our UMs. In Section 10.5.5 of Chapter 10, we present the potential cost ranges from this analysis for each area of uncertainty, reporting on P10/P90 basis. Costs are presented without a TIM adjustment, reflecting the potential investment that may be required in each area.

Our individual UM cases in Appendices 10.01 to 10.15 outline the key assumptions used to undertake Monte Carlo analysis in each area and provide full details on the input assumptions used in our modelling. In the case of re-openers, Monte Carlo analysis is presented on a post TIM basis within individual UM cases – within Chapter 10 and this Appendix all values are reported without a TIM adjustment.

6) Step 5 - Quantifying the overall customer impact

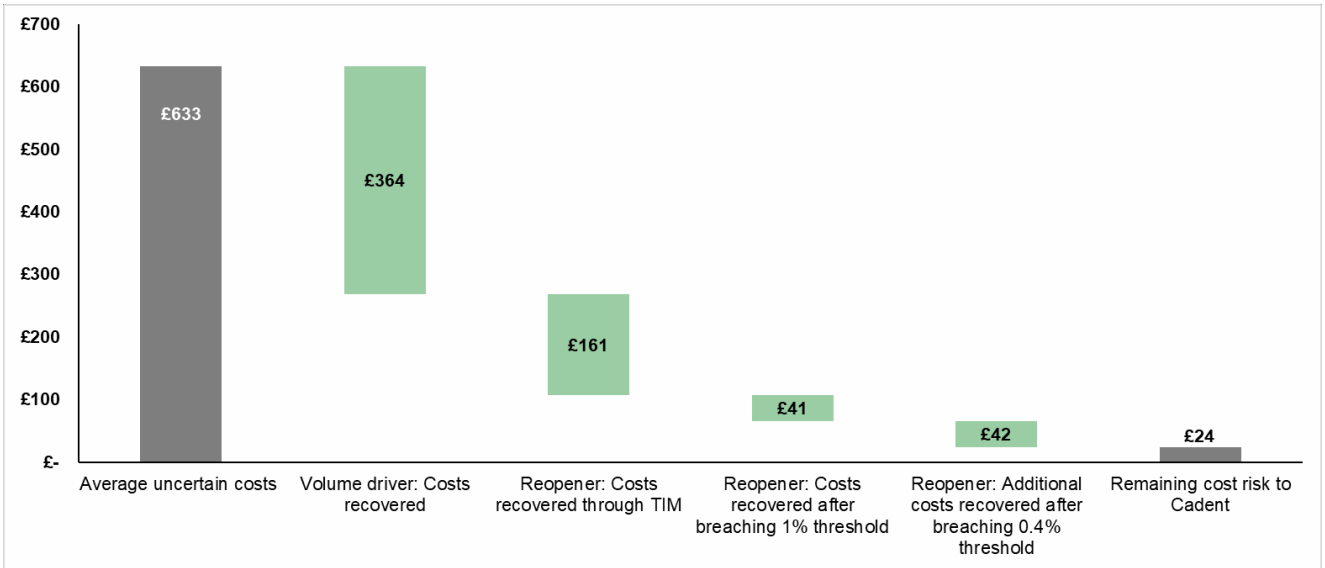


In Section 10.5 of Chapter 10 in our Business Plan, we summarise the cost range for each of proposed UM. We have also analysed the package of UMs to understand the potential level of risk associated with our plan in RIIO-2.

To calculate this range, we undertook Monte Carlo analysis, running iterations across each of our proposed UMs simultaneously to understand the total impact across our Business Plan. This provides a range of potential costs that may be incurred in the areas of uncertainty that we have identified. As outlined in Chapter 10, this analysis suggests a potential range of costs from £348m (P10) to £895m (P90) with a mean of £633m over RIIO-2 (this is a range of 5% to 13% of totex (mean 9%).

Figure 8 below summarises the impact of our proposed UMs on the average uncertain cost identified in our analysis.

Figure 8:Impact of our proposed UMs on uncertain cost range (£m, 18/19 prices)



From our estimated average uncertain cost of £633m over RIIO-2, we have considered the allocation of costs as followed:

- **£364m** associated with volume drivers (of pass through for smart meter roll-out costs) would be funded through customer bills. This assumes that all costs are incurred efficiently in line with agreed unit rates.

- **£161m** of costs associated with uncertain areas identified as reopeners would be recovered through TIM. This is equivalent to (1 – assumed incentive rate of 40%) multiplied by the total average uncertain costs estimates in these areas.

- **£41m** of the remaining uncertain costs associated with reopeners would be recovered after breaching a 1% materiality threshold.

- **£42m** would be additionally recovered through reopeners if the materiality threshold was adjusted downwards to 0.4% of average annual revenues. Further discussion on this adjustment is provided in the box below.

Review of the materiality threshold

The RIIO-1 framework uses a materiality threshold of 1% of average annual revenue (post TIM) that can be logged up over the length of the 8-year price control.

In their Sector Specific Methodology Decision document, Ofgem has set out that they intend to consult on the materiality threshold at draft determinations. We agree that this needs to be consulted on at that stage of the RIIO-2 price control review process, once more information on the package is available, including the financeability of companies plans.

A decision has already been made on shortening the duration of the price control from 8 years to 5 years. This reduction will mean companies have less time to reach the materiality threshold and are thus less likely to reach it and would need to absorb residual costs. As such, we believe that the materiality threshold should be adjusted in line with the reduction in control length from 1% of average annual revenue to around 0.6%.

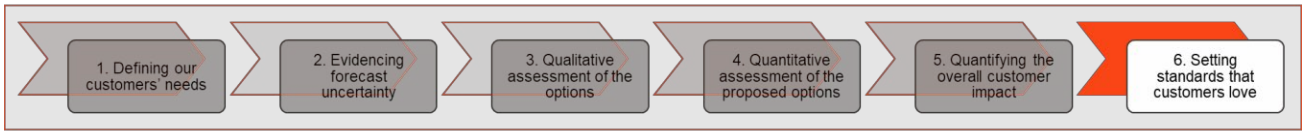
It is also expected that the RIIO-2 sharing factors (TIM) will be lower than in RIIO-1, this would also reduce the likelihood that a company will reach the materiality threshold and increase the likelihood that their shareholders will need to absorb costs. As such, we would suggest that a reduction in the materiality threshold would be required. If the sharing factor for GDNs was set at 40%, compared to c. 63% in RIIO-1, then this would suggest a further reduction in the materiality threshold from around 0.6% to just under 0.4% of average annual revenue.

As shown in Figure 8**Error! Reference source not found.** above, using a materiality threshold of 1% that is evaluated on a post TIM basis could leave a residual mean cost of approximately £66m that our shareholders would need to bear. Re-running our Monte Carlo analysis with an adjusted materiality threshold equivalent to 0.4% of average annual revenues that is evaluated on a post TIM basis reduced this residual mean risk to approximately £24m over RIIO-2. This suggests with the operation and management of the UMs proposed, the residual risks that the customers and the networks face could be much more contained.

Our proposed mechanisms reduce both the materiality and volatility of the risks we face from identified uncertainty. Customers benefit from the introduction of mechanisms, compared to including significantly uncertain costs in our base plan. Ensuring we have a mechanism to recover costs for future needs and requirements that are currently uncertain also means we will be able to continue to deliver for our customers in RIIO-2.

Our proposed UMs are built on the assumption that the re-opener materiality threshold will be reduced to less than 0.4% of revenue. If this was not the conclusion of Ofgem's consultation, we would need to adjust our plan accordingly.

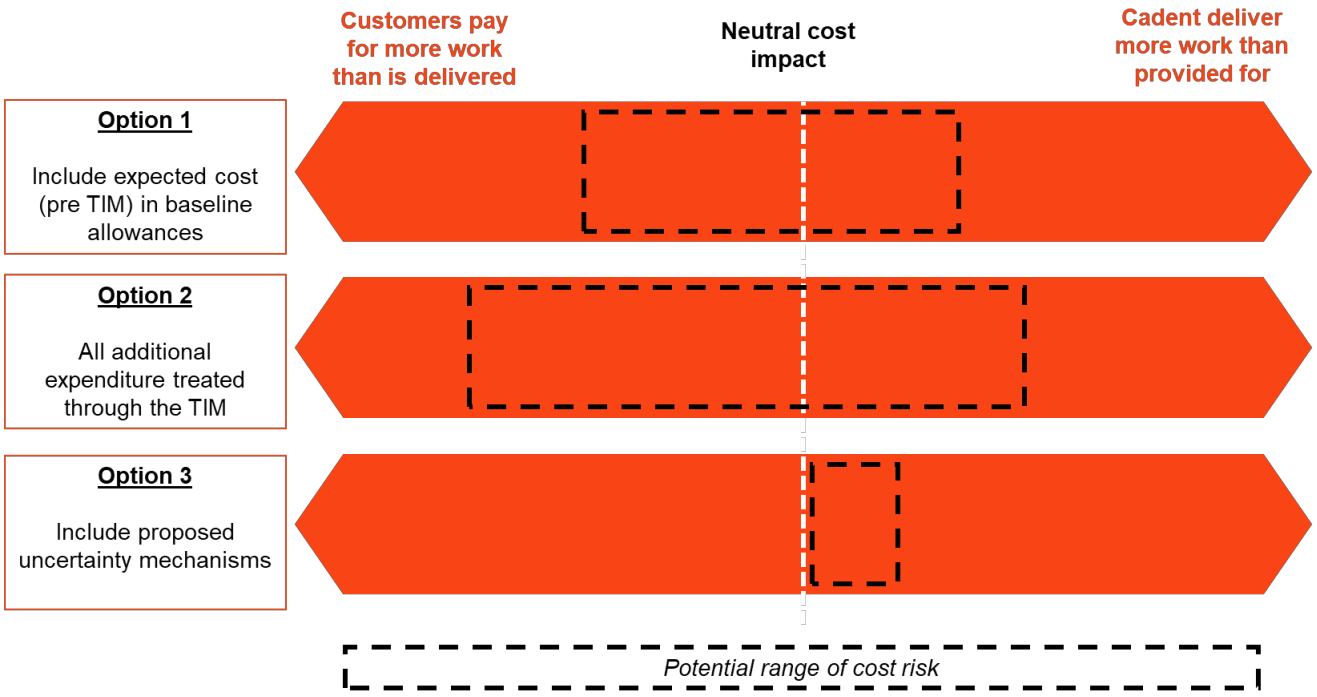
7) Step 6 - Setting standards that customers love



As discussed in Section 10.6.5 of Chapter 10, we have tested our approach to risk and our Business Plan proposals in our qualitative and quantitative survey as part of our Business Plan testing. In general, customers found the way Cadent plans for risks and uncertainties to be acceptable, although further views were provided on in relation to bill stability that do pose some challenge to the proposed use of UMs. However, as discussed in Chapter 10, we believe on balance through our assessments that we should maintain our proposed bespoke mechanisms. We are open to further conversations with Ofgem to alternative approaches, where further information may be available prior to final determination that reduces the need for an UM.

Our proposals also recognise trade-off that exists between sharing exposure of cost risks from future uncertainty with customers. Figure 9 below summarises the range of possible scenarios that could be taken.

Figure 9: Spectrum of options for sharing cost risks from uncertainty with customers



- **Option 1: Include expected costs (pre-TIM) in baseline allowances:** At one extreme, we could include the costs we have identified in Chapter 10 in our baseline allowances. This would be based on the mean cost risk implied from our Monte Carlo analysis, on a pre-TIM basis. However, this option places a significant cost risk onto customers, and opens the potential for future windfall gains and losses. There is also potential for cost risk exposure to Cadent if allowances aren't adequate to address risks that materialise in the future.

- **Option 2: All additional expenditure treated through the TIM:** In contrast to option 1, we could decide to attempt to manage the costs risks we have identified in Chapter 10 as a company within RIIO-2, and recovered a share off any overspend through the TIM. This would place a significant cost risk on to customers, with the potential for material additional expenditure compared to the base plan. This also creates a risk for Cadent, given that the TIM only provides allows a share of additional expenditure beyond base plan to be recovered from customers.
- **Our proposals – Option 3: Include UMs:** Our proposed package of UMs addresses these trade-offs and ensures that funding is in place to undertake future work that is currently unforecastable. It also ensures that customers only pay for work that is undertaken, and at an efficient estimated level of costs.

As part of considering the sharing of risk between Cadent and our customers, we have also considered the specific design of each of our proposed mechanisms, as detailed in individual UM cases. This includes how the mechanism will work in practice, and how calibration of relevant unit costs may be undertaken. As part of this process, we have also considered any additional checks and balances that may be required to provide additional protection to customers.