Cadent
Your Gas Network

Appendix 09.23

Known above 7 bar AGI reinforcements

RIIO-2 Spend: XXXX

Investment Decision Pack Overview

This Major Project Engineering Justification Framework outlines the scope, costs, and benefits of our proposals for reinforcements that are known to be required on our above 7 bar above-ground installations (AGIs). This pack comprises this engineering justification paper (major project template). The work is growth driven, and as such no CBA is required.

Overview

Cadent has over 600 AGIs, operating on the > 7 bar system, across its 4 gas networks; these either act as offtakes from the National Transmission System or regulate pressure within the networks.

We have an obligation under our licence conditions to design each site to be able to supply gas up to and including a 1-in-20 year peak gas demand. As part of the annual demand forecasting process, we have identified a number of sites, where there is insufficient resilience to meet the peak 1-in-20 year gas demand at some point throughout the RIIO-2 period, without a capacity-increase at specific AGI sites.

Having first examined and ruled out pipeline solutions we undertook a study across these sites. This study identified the components on the site that were under-capacity and considered the buildability of the required upgrades. We developed designs for two options - to meet the forecast peak 1-in-20 year 2026 demand and 30% less than the peak 2026 forecast. Across each component, a range of different solution-options were considered including upgrading each component in-situ to the need for a full rebuild across multiple components to achieve the required flows. We also considered how the programme as a whole should be delivered and whether we should invest based on forecast demand increases or only on demand increases already observed

Ultimately, we have looked for ways to manage the capacity-risk, investing at the optimum time in the right combination of assets when the demand-increase is certain.

As a result, we have developed the following programme options:

- **Option 1**: Upgrade all sites that are under-capacity in 2019
- **Option 2:** Upgrade all sites that are under-capacity by 2021

Within these options, we have considered the optimum phasing for deliverability and to minimise capacity risk, by upgrading the sites with the largest number of customers-at-risk first, looking at both a 3 or 4 year programme of work.

Our preferred option, option 1, delivers capacity-upgrades to the 13 sites that are under design capacity in 2019, over a 4-year period, with an associated capex investment of XXXX.

We have developed an uncertainty mechanism to cover the scenario of identifying further sites during RIIO-2, which require capacity upgrades to meet future peak 1-in-20 year gas demand. This uncertainty mechanism is discussed in Appendix 10.08 Reinforcements.

Material changes since October

Two specific pieces of work have been concluded:

- A feasibility study to scope and estimate the required capacity upgrades at each site has completed
- Sensitivity analysis on the demand forecast to inform which sites should be included in our base-case

This has led to our capex investment increasing by around **XXXX** over the 5 years.

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2. Summary Table

Name of Project	Known above 7 bar Above Ground Installations (AGI) reinforcements		
Scheme Reference	Cadent investment line reference 130a, 130b, 130d, 211a, 211b		
Primary Investment Driver	Growth/Security of supply		
Project Initiation Year	2020		
Project Close Out Year	2025		
Total Installed cost estimate (£)	**XXXX**: Design and build of capacity-upgrades to 12 sites Construction-only of a further 1 site (design of 1 project begun in RIIO-1) 11 sites require capacity-upgrades to multiple components, 2 sites require meter-only capacity-upgrades. Costs in 2018/19 price base		
Cost Estimate accuracy (%)	±26%		
Project Spend to date (£)	**XXXX**		
Current Project Stage Gate	Study completed to inform RIIO-1 Business Plan		
Reporting Table Ref	3.01 LTS, Storage & Entry – PRS & Metering		
Outputs included in RIIO-1 Business Plan	None		
Spend apportionment	**RIIO-1**	**RIIO-2**	**RIIO-3**
	XXXX	**XXXX**	**XXXX**

Table 1: Summary Table

The above investment will deliver capacity-upgrades to the 13 sites that have been identified as not reliably meeting the required 1-in-20 year 2019 peak gas demand (a Cadent Licence condition).

Due to the uncertainties in forecasting gas-demand, we have chosen not to include capacity-upgrades for sites that may become under-capacity in RIIO-2 within this base-case. However, we may identify other sites that become under-capacity due to the fluctuations in peak gas demand during RIIO-2. A separate uncertainty mechanism discussed in Appendix 10.08 Reinforcements, has been developed to cover this scenario.

3. Project Status and Request Summary

This investment will fully complete all studies, design and construction work to upsize a number of above-ground gas installations (AGIs) across the four distribution networks, ensuring reliable compliance with our current demand requirements (our Gas licence conditions state that are network must be able to deliver gas for a 1-in-20 year peak winter demand).

A study has been completed during RIIO-1 to inform the investment case for RIIO-2.

4. Problem Statement

Gas demand is constantly changing; while energy efficiency is improving and thus reducing gas demand new industrial and housing developments are still emerging across the network. In certain areas increases from new demands are exceeding the background reductions creating a net increase in the requirement for gas. Based on our current and forecast gas demand, some of our AGIs are now over design capacity and require upsizing. Our Gas Licence places an absolute duty on us to provide a gas supply to customers for all demand scenarios up to and including a 1-in-20 year peak winter event.

An extensive review of the above 7 bar gas network and its resilience was undertaken in early 2019 to look for areas in which demand increases were reducing security of supply. For some of these instances we have been able to identify pipeline reinforcements on operational changes to the way in which we manage the network to maintain resilience e.g. opportunities where pressures could be increased, or other parts of the network could be used, to provide the required gas to meet forecasted 1-in-20 year peak demands. This network optimisation is completed as part of our normal (business-as-usual) gas supply-demand management.

Despite network optimisation, several sites were identified as over design capacity. Some of these sites were over design capacity based on 2019 peak-demand forecasts, others failed to meet forecast peak demand in RIIO-2.

To provide robust site resilience to mitigate the effects of equipment failure or breakdown, it is good practice to provide a minimum of two streams, providing a duty and standby stream both capable of 100% of the peak 1-in-20 year gas flow. This is how the network was originally designed and customers have always had this designed level of network resilience. Customer need for gas is greatest when it is coldest and, in most demand, a failure of an AGI under these conditions is unacceptable and as such they were designed with built in resilience.

However, at some sites this resilience has been eroded due to recent increases in gas demand. Some of these sites are significantly over design capacity and have already fully used any on-site asset redundancy by operating certain components on a duty-assist basis. That is to say, during high demand both streams are required to meet peak demands, if one stream fails the customers will lose supply when they need it most. On many of the sites identified, our asset components (filters, heaters, regulators) are operating in duty-assist during peak winter events. This arrangement does not provide sufficient resilience against asset component failures during these peaks 1-in-20 winter events. We are therefore investing to recover our lost resilience by upsizing our sites.

Our modelling has identified several sites that require upsizing to meet future 1-in-20 peak demands. The following table summarises the required site design capacity, the customers at risk, the current peak demand (2019) and the forecast peak demand (2026). The monetised risk for avoiding the risk of customers suffering interruption to supply, based on a 1-in-20 year event, is also detailed.

All the sites identified are either ‘single source’ or ‘weak multiple source’. A ‘single source’ site means that the downstream gas network is only provided by this single site. No other parts of the network can support the gas supply in this area in the event of a site failure. This means that on-site asset resilience is therefore needed to ensure that the sites operate reliably. A ‘weak multiple source’ site, in comparison, means that there are small parts of the network that can be supported from other sources in the event of a failure – a considerable proportion of the customers supplied by the site would still be at risk of a supply interruption in the event of a site failure.

Region	Site	Network resilience	Current stream design capacity**	Current 1-in-20 yr. peak demand (2019)**	Future 1-in-20 yr. peak demand (2026)**	Customers at Risk	Monetised Risk (£m pa)
EoE	Westfield	Single Source	4,160	5,107	6,200	4,000	**XXXX**
	Teversham	Single Source	52,100	63,720	66,000	77,000	**XXXX**
	Eye Green Offtake	Single Source	127,000	126,697	160,600	158,300	**XXXX**
	West Winch Offtake	Single Source	62,500	63,003	78,920	78,700	**XXXX**
Lon	Woodford	Weak Multiple Source	19,200	27,300	35,000	50,000	**XXXX**
NW	Longridge Road	Weak Multiple Source	18,000	26,600	34,000	32,600	**XXXX**
	Barrowford	Single Source	17,500	26,200	33,000	39,100	**XXXX**
	Accrington	Weak Multiple Source	14,200	13,100	16,500	28,000	**XXXX**
	Thornton	Single Source	24,400	34,100	43,000	46,900	**XXXX**
	Rossendale	Single Source	21,200	28,200	35,200	34,300	**XXXX**
	Euxton	Single Source	20,400	38,500	48,000	49,500	**XXXX**
	Ashton under Lyne	Weak Multiple Source	41,700	43,800	56,200	60,500	**XXXX**
	Hambleton	Single Source	4,200	8,033	10,300	10,000	**XXXX**
WM	Gentleshaw	Weak Multiple Source	71,900	80,900	102,000	104,000	**XXXX**
	Kinver	Weak Multiple Source	8,640	12,470	16,000	21,100	**XXXX**
	Kingswinford	Weak Multiple Source	26,700	39,464	50,000	49,300	**XXXX**
	Stratford Offtake	Weak Multiple Source	26,500	26,500	35,000	33,100	**XXXX**

Region	Site	Network resilience	Current stream design capacity**	Current 1-in-20 yr. peak demand (2019)**	Future 1-in-20 yr. peak demand (2026)**	Customers at Risk	Monetised Risk (£m pa)
	Soudley	Weak Multiple Source	7,350	6,918	8,800	8,600	**XXXX**
	Ebstree No2	Single Source	391	404	510	505	**XXXX**
	Dawley	Weak Multiple Source	32,000	75,300	76,300	35,000	**XXXX**

**Capacity/Demand figures in above table quoted as peak hour (scm/hr)

Ta[illegible]s with stream identified as significantly below design capacity to meet the 1-in-20 year peak gas demand (2026).

Our hydraulic modelling also identified a further 11 sites where the only site component under capacity was the metering system. The following table summarises the metering-only sites.

Region	Site	Network resilience	Current design capacity**	Current 1-in-20 yr. peak demand (2019)**	Future 1-in-20 yr. peak demand (2026)**	Customers at Risk
EoE	March	Weak Multiple Source	7,980	14,130	14,130	17,600
	Maltby AGI	SMS	7,570	18,134	18,154	22,600
	Blaby EM Offtake	Weak Multiple Source	62,670	61,825	62,670	87,000
	Walesby EM Offtake	Single Source	4,200	4,399	4,410	5,500
Lon	Holloway Lane Station 184	Single Source	53,300	56,605	57,459	71,800
	Redbridge Lane Station 186A and B	Single Source	220,000	231,970	234,276	293,000
	East Ham PRS 77	SMS	19,300	17,689	17,788	22,235
	Slough Holder Site Station 221 & 628	Weak Multiple Source	36,100	44,575	45,067	56,300
NW	Runcorn Halton Road	Weak Multiple Source	23,200	26,940	27,050	33,800
	Kirkby PRI	Single Source	56,100	54,243	54,345	67,900

Region	Site	Network resilience	Current design capacity**	Current 1-in-20 yr. peak demand (2019)**	Future 1-in-20 yr. peak demand (2026)**	Customers at Risk
	Ormskirk PRI	Single Source	41,500	62,063	62,604	78,255

Table 3: Sites with under-capacity metering

We would seek to time investment to align with confidence in increased demand. That is to say, we would not necessarily invest to increase capacity on the basis of forecast demand, in order to avoid asset stranding in the event that the demand does not emerge. Similarly, we would not want to leave too long a period between demand becoming certain and responding to the increased need.

We have looked to see when our sites would become undersized based on the 2019 to 2026 forecast increases. We carried out several sensitivity tests on the above results. We reduced the future 2026 demand by 10%, and we also looked at which, if any, sites had actual, proven-capacity above design[1]. While this is not a sustainable approach in the long term, it is a viable operating strategy that could be used to delay the need for investment early in RIIO-2.

We have looked at four different scenarios to assess which year we become 'at risk' due to under-sized AGI sites:

- Scenario 1: base-case demand scenario. Peak demand exceeds the design capacity
- Scenario 2: base-case demand scenario. Peak demand exceeds actual, proven-capacity[1].
- Scenario 3: base-case – 2026 demand 10% less than forecast. Peak demand exceeds design capacity
- Scenario 4: base-case – 2026 demand 10% less than forecast. Peak demand exceeds actual, proven-capacity.

The results of this analysis have shown that some sites are already under design capacity (based on 2019 peak demand); others would only become under capacity in the middle of RIIO-2 if demand increases as predicted. We have used this view of risk to inform our programme options discussed in Section 6.

Region	Site	Scenario 1	Scenario 2	Scenario 3	Scenario 4
EoE	Westfield	2020	2020	2020	2020
	Teversham	2019	2019	2019	2019
	Eye Green Offtake	2019	2019	2019	2019
	West Winch Offtake	2019	2019	2019	2019
Lon	Woodford	2019	2020	2019	2020
NW	Longridge Road	2019	2019	2019	2019
	Barrowford	2019	2019	2019	2019
	Accrington	2022	RIIO3	2023	RIIO3
	Thornton	2019	2019	2019	2019
	Rossendale	2019	RIIO3	2019	RIIO3
	Euxton	2019	RIIO3	2019	RIIO3

[1] Additional capacity could be available because 1) the available streams can be run in duty-assist rather than duty-standby 2) individual units can be run slightly above normal operating velocities to achieve a higher capacity 3) the actual unit installed has an actual capacity greater than the design capacity.

Region	Site	Scenario 1	Scenario 2	Scenario 3	Scenario 4
	Ashton under Lyne	2019	2019	2019	2019
	Hambleton	2019	2019	2019	2019
WM	Gentleshaw	2019	2025	2019	RIIO3
WM	Kinver	2019	2019	2019	2019
WM	Kingswin-ford	2019	2023	2019	2024
WM	Stratford Offtake	2019	2021	2019	2022
WM	Soudley	2021	RIIO3	2022	RIIO3
WM	Ebstree No2	2019	RIIO3	2019	RIIO3

Table 4: Year that each site exceeds its design capacity, based on demand scenario

Region	Site	Scenario 1	Scenario 2	Scenario 3	Scenario 4
EoE	March	2019	2019	2019	2019
EoE	Maltby AGI	2019	2019	2019	2019
EoE	Blaby EM Offtake	2026	2026	RIIO3	RIIO3
EoE	Walesby EM Offtake	2019	2019	2019	2019
Lon	Holloway Lane Station 184	2019	RIIO3	2019	RIIO3
Lon	Redbridge Lane Station 186A and B	2019	RIIO3	2019	RIIO3
Lon	East Ham PRS 77	RIIO3	RIIO3	RIIO3	RIIO3
Lon	Slough Holder Site Station 221 & 628	2019	RIIO3	2019	RIIO3
NW	Runcorn Halton Road	2019	RIIO3	2019	RIIO3
NW	Kirkby PRI	RIIO3	RIIO3	RIIO3	RIIO3
NW	Ormskirk PRI	2019	RIIO3	2019	RIIO3

Table 5: Year that meter exceeds its design capacity, based on demand scenario

Investment Drivers

The key investment driver is to comply with our 1-in-20 year peak demand and adhere to our gas licence conditions through a cost-effective investment programme.

The key driver is therefore to maintain **security of supply** to our customers under the increasing demands identified in certain areas of our network.

Key challenges

The primary challenges with delivering this work are:

- Delivering the required equipment capacity upgrades without any impact on the supply-demand balance (some sites have narrow construction windows where site outages are possible, which necessitates specific construction methods and solutions).
- Coordinating the proposed capacity upgrades with other asset-health upgrades (such as remediation on filters or preheaters) to deliver the work cost-effectively.

Key Milestone Dates

The detailed implementation programme is dependent on the chosen investment option. For all chosen options, we have taken a risk-based approach to prioritise the most under-capacity sites earlier in RIIO-1.

Most sites can be designed, and the required capacity upgrades constructed, within two calendar years. We have assumed that we complete design and commercial negotiations in Year 1, with construction and commissioning in Year 2.

Understanding project success

We need to provide a resilient network, with AGI sites able to reliably operate at the peak 1-in-20 winter forecast gas demand, to comply with our licence conditions (an extract from these licence conditions are included in Appendix 3) and to be able to meet our customers' demand when they need it most in the coldest winters.

4.1. Related Projects

Walesby Offtake was identified as having a capacity below the forecast 2019 peak demand. However, the entire FWACV metering system will be replaced under our Offtakes and PRS Metering Systems Asset Health Driver (see Appendix 09.10). The proposed new metering system has sufficient capacity to meet the 2026 demand; therefore, Walesby has not been included in this investment case.

Below is an outline of specific learning from past projects that we have used to inform this investment case.

During RIIO-1, we have delivered several AGI upgrades.

<table>
<tr><th>Scheme name</th><th>Lessons learnt</th></tr>
<tr><td>Peters Green</td><td rowspan="4">At the time of writing, the schemes named in the first column were moving into construction. During pre-construction, several issues arose, leading to an additional 35% contingency budget being required:
• Missing scope due to the low level of design completed to date
• Underestimation of material costs
• Inaccurate assumptions around construction duration and complexity
• Various unforeseen risks or issues (e.g. ground conditions and buried pipework).

Similar issues were also highlighted during the engineering study detailed in this document; therefore, 35% is a reasonable contingency sum to incorporate into our RIIO-2 costs.</td></tr>
<tr><td>Kenton</td></tr>
<tr><td>Hollinwood</td></tr>
<tr><td>Rochdale</td></tr>
</table>

Scheme name	Lessons learnt
Dawley	

Table 6: RIIO-1 lessons learnt for AGI rebuilds

We have also captured detailed learning from the level of programme management and support staff required to manage the design and construction and to provide appropriate contract and commercial management.

The team required to provide this support for the five AGI schemes noted above was **XXXX** per annum across a 2-year programme (nominal prices). We have used this learning to inform the necessary Cadent direct costs for delivery of our capacity upgrades in RIIO-2. The team was comprised of:

- A lead project manager
- Two project engineers
- Two construction interface engineers
- A design coordinator
- A quantity surveyor
- A planner

Based on this learning, we have applied a 16% uplift on our total installed costs to account for the above Cadent programme management and delivery team for RIIO-2.

4.2. Project Boundaries

This project includes for the upsizing of equipment that has insufficient capacity to meet gas flows. The asset health of the equipment has been taken into consideration when reviewing feasible options (e.g. where a filter has been identified as below capacity and is known to be in poor asset health, the engineering team has looked at replacements and upsizing of the entire filter system rather than providing a further filter stream).

Assets have been excluded from the scope of this investment case if they require investment due to their asset health, condition or safety, or because of non-conformance with policy and regulation.

We have tailored the investment at each site to deliver the required capacity at the lowest intervention costs. Depending on the site, this means that different assets will be in scope. The assets in scope for each site are recorded in our engineering study. Refer to Appendix 1 for more information on the scope of each site capacity upgrade.

5. Project Definition

5.1. Supply and Demand Scenario Discussion and Selection

The future demand for gas has been considered across all four gas distribution networks to inform this investment case. A summary of our historical and future forecast gas demand for each region is shown in the figure below. The graphs generally show that the forecast peak gas demand dropped in the early part of RIIO-1 but has shown a general growth through RIIO-1 which is expected to continue into RIIO-2.

	ND Plan Year	Period	EA 1:20 Peak Day Forecast (mcm/d)	EM 1:20 Peak Day Forecast (mcm/d)	NL 1:20 Peak Day Forecast (mcm/d)	NW 1:20 Peak Day Forecast (mcm/d)	WM 1:20Peak Day Forecast (mcm/d)
RIIO GD1	2014 Plan	2013/2014	31.764	39.521	41.369	46.936	34.639
	2015 Plan	2014/2015	33.202	38.968	42.808	46.674	34.189
	2016 Plan	2015/2016	29.393	35.309	37.388	43.036	31.156
	2017 Plan	2016/2017	29.028	36.399	37.100	42.835	31.791
	2018 Plan	2017/2018	29.358	36.955	37.157	44.088	32.349
	2019 Plan	2018/2019	29.960	37.970	37.157	44.088	33.330
	2020 Plan	2019/2020	29.960	37.970	36.910	43.190	33.330
	2021 Plan	2020/2021	30.190	38.330	37.330	43.630	33.640
RIIO GD2	2022 Plan	2021/2022	30.240	38.680	37.480	43.760	33.740
	2023 Plan	2022/2023	30.390	38.640	37.460	43.680	33.710
	2024 Plan	2023/2024	30.420	38.660	37.520	43.850	33.810
	2025 Plan	2024/2025	30.490	38.700	37.740	43.960	33.860
	2026 Plan	2025/2026	30.450	38.560	37.680	43.890	33.790

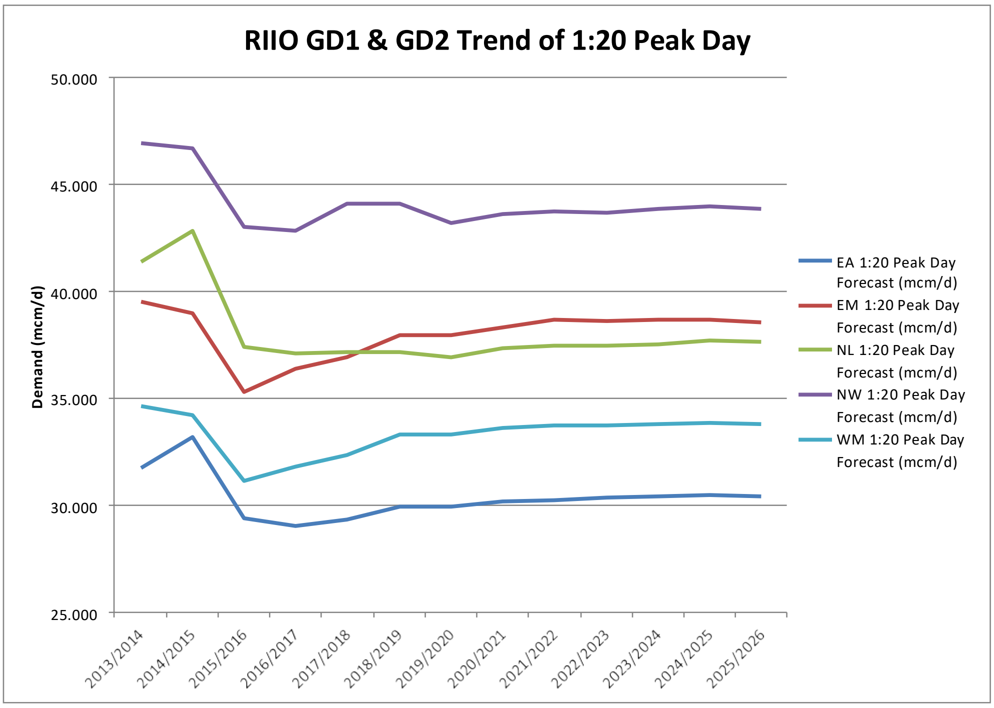

Figure 1: Peak Gas demand RIIO-1 and RIIO-2 trends[2]

While the long-term trend for gas annual consumption is, on average, continuing to decline, we are not seeing any appreciable indication of a decline in peak demand. Our Licence requires us to design our network to meet this 1-in-20 peak condition – that is we must be able to supply gas to our customers when they need it most. We are also observing increases in demand in parts of our network – driven by new housing and industry

[2] Analysis of 2018 National Grid Demand Forecast Scenarios (Supply and Demand and Actual Flow data) to account for the observed 2019/20 growth in gas demand, based on the 2018 National Grid Gas Ten Year Statement, (accessed 17/10/19)

increasing demand beyond the reductions seen from increased efficiency. This local increase in peak demand in certain areas of the network is driving the specific AGI capacity upgrades discussed in this paper, as evidenced in the above graph.

The latest 2019 National Grid Future Energy Scenarios (FES)[3] show an increase in national demand in the 'steady progression' and 'consumer evolution' scenarios in the short to medium term. The Energy Networks Association's (ENA's) Common RIIO-2 Scenario[4] looking out to 2030, agreed by all the networks and informed by FES 2018, shows a UK gas peak demand of 5,000GWh in 2030, which is only marginally lower than the last peak published by National Grid in its Winter Outlook Report for 2018/19[5].

We have undertaken several sensitivity tests on the demand forecast, to see how it has impacted on:

1. The year each site exceeded the stated design capacity and thus required a capacity upgrade
2. The size of the upgrade required

The results of 1. are discussed in Section 4 and have shown many sites need to be upsized in the early years of RIIO-2, and this list of sites is not materially impacted by variation in demand forecast.

The results of 2. are discussed against each option in Section 6.

5.2. Project Scope Summary

The scope of this project covers:

- All required capacity upgrades to assets from the site inlet to site outlet of the AGI, up to and including any site isolation valves.
- All asset components within the AGI site boundary are within scope if they have been identified as under capacity.

The scope of each capacity upgrade on a specific site is included in Appendix 1.

[3]. Future Energy Scenarios July 2019, accessed 23/10/19
[4] ENA Common RIIO-2 Scenario Report September 2019 Final v2, accessed 23/10/19
[5] National Grid Winter Outlook Report 2018/19, accessed 23/10/19

6. Options Considered

We have considered the following programme-options in this investment case:

- **Initial Option A**: Reconfigure network to achieve compliance
- **Initial Option B:** Upgrade capacity for sites with duty-assist configuration only (without a dedicated standby)
- **Option 1**: Upgrade capacity for all sites that have insufficient design capacity to meet the 2019 peak demand, 1 in 20 year forecast only; sites to be upgraded to meet 2026 peak demand
- **Option 2**: Upgrade capacity for all sites that have insufficient design capacity to meet the peak 1-in-20 year forecast based on the 2019, 2020 and 2021 demand forecasts; sites to be upgraded to meet 2026 peak demand

As part of these options, we have carried out sensitivity testing based on the 2026 peak demand. We have assessed the impact on the total installed costs for site capacity upgrades if the forecasted increase between 2019 and 2026 is 30% less.

We have not used cost-benefit analysis (CBA) to inform our decision, having taken the straightforward, compliance-based approach of looking at the supply and demand risk, along with deliverability and affordability, in order to select the preferred plan.

To inform both programme Options 1 and 2, we undertook a detailed engineering study on all sites identified as 'under capacity' during RIIO-2. For each site requiring a capacity upgrade to multiple components, a study has been completed by an engineering consultant to assess which asset components on each site are under capacity. A hydraulic review of all assets was completed, from site-inlet to site-outlet, across all pressure tiers. This then enabled us to confirm which assets needed upsizing. The design team then looked at the most cost-effective way to increase the capacity and upgrade or replace the components while maintaining the operation of the site. As most of these sites are either single feed or weak multiple feed, many of them have limited, if any, opportunity for a planned outage, which significantly reduces the possibility of replacing key components and often drives the need for building a brand-new parallel system (a worst case could require a whole-site rebuild) while retaining the existing assets during the construction works.

When the buildability of the required upgrades and the limited available space on the current site footprint is considered, some sites could require land purchases and or site relocations.

For all sites, the following solution options were investigated as part of the engineering study. The minimum intervention has always been selected where possible. Space, pipework configuration, buildability and the availability of a site outage has a significant impact on which option is feasible. For many sites, each specific component (i.e. filters, heaters, meters) have often required a different solution option.

Option	Reasons for selecting the option
Option A1: Replace components in-situ, during a planned outage	Where there is sufficient space, to lift out the old component, modify pipework and install a large asset, during a short outage window.
Option B1: Provide a third stream to increase capacity	Where there is adequate space, to insert a 3rd stream. Often not preferred by Operations because of the different makes and models of kit across the 3 streams.
Option C1: Rebuild a specific asset-component in a new location on site	This is often the only technically viable option where a site outage isn't available.
Option D1: Rebuild the entire site in a new location (land adjacent to site or spare-land on existing site)	Where a significant number of assets on site are under capacity, and the site is in poor condition, a full site rebuild can often be the best way to upsize the site when an outage is not available.

Table 7: The solution-options considered for the capacity upgrades

As discussed, a pre-feasibility study has been completed to date, which has confirmed a preferred option for each site, a defined scope of work and a range of risks, assumptions and contingencies. The total installed costs per site are summarised in Section 6.1, with more detail of scope and cost contained in Appendix 1 and 2.

6.1. Option Summaries

Initial Option A: Reconfigure network to achieve future gas demand

As discussed in Section 4, the business looks for opportunities to provide security of supply during peak 1-in-20 year winter events as part of business-as-usual. The options investigated include rebalancing the network and increasing flows from other parts of the network or increasing pressures to allow an increased gas flow to the area.

For all 19 sites identified as ‘at risk’, the ability to optimise and reconfigure the network is very limited. Half of the sites are single feed; the remaining are weak multiple feeds. Any network reconfiguration has already been investigated; no further opportunity has been identified. This option has therefore been discounted.

Initial Option B: Achieve capacity at AGI with duty-assist asset configuration

We have considered upsizing our sites with assets running as duty-assist, without a dedicated standby stream i.e. a change in historic design standards and therefore a reduction in customer service. This has the potential to reduce the costs of construction: the sizes of upsized components would be smaller but interconnecting pipework would still need to be sized for the peak flow. Much of the cost of installation comes from the complexities of construction with only limited outage windows, which in turn cause new skids and equipment to be built offline rather than assets being upsized in situ. Therefore, the savings tend to be in material costs alone.

All these sites need to be upsized because there is no network resilience; they are all single source or weak multiple source sites. This means that the only redundancy against site outage is within the asset redundancy provided for each component. A single component failure in a duty-assist scenario could cause an immediate impact on customer gas supplies.

Based on the range of flows identified across all sites, a loss of a single stream due to asset failure could lose between 5,000 and 50,000 customers on average during a peak winter event (1-in-20 years). The benefit from avoiding a 1-in-50 year supply interruption of more than 24hrs to 30,000 people is **XXXX** (per event), based on customers’ willingness to pay.

Savings of over **XXXX** per site would need to be realised to make this reduced resilience cost-beneficial, but a reduction in resilience is not what our customers want.

Reducing asset redundancy on these sites in the longer term has been dismissed as a viable option due to the unacceptable risk that an asset failure would have on customer gas-supplies during a peak winter event. This option would result in a reduced standard of service from that which customers previously received.

Option 1: Upsize sites that are under capacity in 2019

Option 1 has identified 12 sites that are already under design capacity in all four scenarios (Section 4) based on the 2019 peak 1-in-20 year demand, and two of these only require capacity upgrades for meter systems. Sites which were under capacity in 2019 but could meet capacity with duty assist were not included. A further site, Dawley PRS, is also part of the RIIO-2 capacity upgrades, bringing the total to 13. Dawley PRS has been identified in RIIO-1 as under capacity and is currently part way through its outline and detailed design phase. This site will not be constructed until the first year of RIIO-2 so has been included within Table 8. In this option, we are only including sites in our base plan which already have peak demand larger than design capacity.

We have looked at the optimum phasing of these sites: We have prioritised the sites based on customers at risk (largest number of customers at risk delivered first). We have then considered deliverability to develop a 4-year programme. We acknowledge the capacity risk that this 4-year programme poses, but have considered our operations teams and our supply chain's capacity and ability to deliver this programme.

This option includes the delivery of the following site capacity upgrades in the following years:

	21/22	22/23	23/24	24/25	25/26
EoE	March (meter-only) Maltby (meter-only)	Eye Green Offtake West Winch Offtake	Teversham Westfield		
NW		Thornton Ashton under Lyne	Barrowford Longridge Road	Hambleton PRI	
Lon					
WM	Dawley			Kinver	
Total	**3**	**4**	**4**	**2**	**0**

Table 8: Proposed phasing of capacity upgrades: Option 1

Using the total installed costs in Section 6.2, the following cost profile has been calculated:

	21/22	22/23	23/24	24/25	25/26	Total
EoE						
NW						
Lon						
WM						
Total						

Redacted due to commercial sensitivity

Table 9: Option 1: Proposed spend profile for RIIO-2: >7 bar PRS Sites and Metering

	21/22	22/23	23/24	24/25	25/26	Total
EA						
NW						
Lon						
WM						
Total						

Redacted due to commercial sensitivity

Table 10: Option 1: Proposed spend profile for RIIO-2: Offtake Sites

If the design capacity for all sites is reduced (increase between 2019 and 2026 is 30% less), the capex required for Option 1 is not impacted.

Option 2: Upsize sites that are under capacity by 2021

This option assumes that we will upgrade all sites that are under design capacity at 2021 in all four scenarios. These are shown in Table 2 in Section 4. This also includes two sites where only the metering systems are under capacity: Maltby and March AGIs. In this option, we would be including costs in our base plan based on forecast increases in demand over the last 2 years of RIIO-1.

For this option, we chose a 3-year programme, to reduce the capacity risk as quickly as possible.

We have looked at the optimum phasing of these sites based on customers at risk**.** This has generated the following priority list and potential delivery year by site.

Note that Dawley PRS has been identified in RIIO-1 as under capacity and is currently part way through its outline and detailed design phase. This site will not be constructed until the first year of RIIO-2, so has been included within Table 11.

	21/22	22/23	23/24	24/25	25/26
EoE	March (meter only) Maltby (meter only) Eye Green Offtake West Winch Offtake	Teversham Westfield			
NW	Ashton Under Lyne Thornton	Barrowford Longridge Road	Hambleton PRI		
Lon	Woodford				
WM	Dawley		Stratford Offtake Kinver		
Total	**8**	**4**	**3**		

Table 11: Proposed phasing of capacity upgrades: Option 2

This proposed list of priority sites has generated the following programme spend profile for this option.

	21/22	22/23	23/24	24/25	25/26	Total
EoE						
NW						
Lon						
WM						
Total						

Redacted due to commercial sensitivity

Table 12: Option 2: Proposed spend profile for RIIO-2: PRS Sites and Metering

	21/22	22/23	23/24	24/25	25/26	Total
EoE						
NW						
Lon						
WM						
Total						

Redacted due to commercial sensitivity

Table 13: Option 2: Proposed spend profile for RIIO-2: Offtake Sites

If the design capacity for all sites is reduced (increase between 2019 and 2026 is 30% less), then the capex required for Option 2 is **XXXX** less (pre-efficiency) than stated in Table 12 and Table 13, which is equivalent to a 3.5% reduction.

6.2. Options Cost Estimate Details

The output from our engineering study has provided us with a total installed cost per site.

A detailed report from our engineering consultant provides all the supporting evidence by site. The following tables summarise the key technical conclusions and preferred options and a high-level cost breakdown by site. Within this report, we have asked our consultants to look at how much the costs for these capacity increases would change and thus test the sensitivity of our RIIO-2 investment case if the demand forecast in 2026 is 30% less than forecast. The results of this sensitivity test are also summarised in the table below.

The total installed cost below is comprised of:

- Initial total installed cost from engineering study, excluding contingency and programme risk and Cadent direct costs
- 35% allowance for programme risk, to cover land purchase, missed scope and other unforeseen risks (see 4.1 for details).
- 16% allowance for Cadent direct costs to cover contract and commercial management, design management, construction supervision (see 4.1 for details)

The detailed site by site cost estimate breakdown can be found in Appendix 2.

Site	**Total Installed Cost (pre-efficiency): Base case demand scenario** (Base case 2026 peak demand)	**Total installed cost (pre-efficiency): Reduced demand forecast** Demand forecast increases by 30% less than forecast between 2019 to 2026	Cost Estimating Accuracy
Eye Green Offtake			
West Winch Offtake			
Teversham		Redacted due to commercial sensitivity	
Westfield			
Ashton Under Lyne			
Thornton			

Site	Total Installed Cost (pre-efficiency): Base case demand scenario (Base case 2026 peak demand)	Total installed cost (pre-efficiency): Reduced demand forecast Demand forecast increases by 30% less than forecast between 2019 to 2026	Cost Estimating Accuracy
Barrowford			
Longbridge Road			
Hambleton PRI			
Woodford		Redacted due to commercial sensitivity	
Dawley			
Stratford Offtake			
Kinver			
Maltby: Metering only			
March: Metering Only			

Table 14: Cost summary by site

The average unit costs of a metering capacity upgrade have been calculated as **XXXX**, based on the component replacements estimated within the engineering study.

With 13 projects, each having a cost confidence ranging between +/-20 and +/- 35%, we have developed a weighted-average cost confidence score which equates to +/-26% for Option 1.

6.3. Options Summary

The following options have been considered to address the capacity issues at the 19 identified sites.

	Initial Option A: Reconfigure network	Initial Option B: Upsize sites with duty-assist asset redundancy	Option 2: Upsize sites that are under capacity in 2019 to 2021	Option 1: Upsize sites that are under capacity in 2019 only
Project start date	As all sites are either single feed or a weak multiple feed and there is insufficient network resilience. There is no further flexibility within the network to provide gas from other sites. This option has therefore been discounted.	As all sites are either single feed or a weak multiple feed and there is insufficient network resilience. Therefore, without full duty-standby asset redundancy, an asset failure would lead to a site outage. This level of resilience is not acceptable to our customers This option has therefore been discounted.	3-year programme to deliver 12 AGI sites, 2 metering sites and 1 RIIO-1 project. Starting in 2021/22.	4-year programme to deliver 10 AGI sites, 2 metering sites and 1 RIIO-1 project. Starting in 2021/22.
Project commissioning date			Various throughout programme, finishing in 2023/24.	Various throughout programme, finishing in 2024/25.
Project design life			20 - 40 years. depending upon component	20 - 40 years. depending upon component
Operating costs			Variable	Variable
Total installed cost			**XXXX**	**XXXX**
Cost estimate accuracy			+/-26%	+/-26%

Table 15: Options summary table

7. Business Case Outline and Discussion

Our programme of work and preferred option has been selected based on the year each site becomes unable to meet the forecast 1-in-20-year peak demand design within a given year, and then further prioritised based on deliverability and risk.

7.1. Key Business Case Drivers Description

The key driver for investment is security of supply, in compliance with our 1-in-20 obligations.

7.2. Supply and Demand Scenario Sensitivities

We have undertaken several sensitivity tests on the demand forecast, to see how it has impacted on this investment case. We have reduced the 2026 demand forecast by varying amounts to assess the impact on:

1. The year each site exceeds the stated design capacity and thus requires upsizing
2. The size of the capacity-upgrade required

For both Options 1 and 2 included in this investment case, a 10% reduction in 2026 demand forecast has no impact on the sites requiring capacity upgrades. All sites included in Options 1 and 2 exceed peak demand in the next two years, and therefore are not influenced by large variances in the 2026 forecast.

The scope and costs for each site capacity upgrade have been based on a future design capacity equal to the 2026 peak demand forecast. Within each option, we have also assessed how much the costs would vary if the increase in demand between 2019 and 2026 was 30% less than forecast. This impact is discussed in each option section.

In summary, for our preferred option (Option 1), we found that a 2026 peak design capacity of 30% less would result in no impact to the RIIO-2 capex required for this investment case (see the costs summarised in Table 14).

7.3. Business Case Summary

The following table summarises all options considered; however, only one viable option has been identified.

<table>
<tr><th></th><th>Initial Option A: Reconfigure network</th><th>Initial Option B: Upsize sites with duty-assist asset redundancy</th><th>Option 2: Upsize sites that are under capacity in 2019 to 2021</th><th>Option 1: Upsize sites that are under capacity in 2019 only</th></tr>
<tr><td>Project start date</td><td rowspan="6">As all sites are either single-feed or a weak multiple feed and there is insufficient network resilience.

There is no further flexibility within the network to provide gas from other sites.

This option has therefore been discounted.</td><td rowspan="6">As all sites are either single-feed or a weak multiple feed and there is insufficient network resilience. Therefore, without full duty-standby asset redundancy, an asset failure would lead to a site outage.

This level of resilience is not acceptable to our customers

This option has therefore been discounted.</td><td>3-year programme to deliver 12 AGI sites, 2 metering sites and 1 RIIO-1 project. Starting in 2021/22.</td><td>4-year programme to deliver 10 AGI sites, 2 metering sites and 1 RIIO-1 project. Starting in 2021/22.</td></tr>
<tr><td>Project commissioning date</td><td>Various throughout programme, finishing in 2023/24.</td><td>Various throughout programme, finishing in 2024/25.</td></tr>
<tr><td>Project design life</td><td>20 - 40 years. depending upon component</td><td>20 - 40 years. depending upon component</td></tr>
<tr><td>Operating costs</td><td>Variable</td><td>Variable</td></tr>
<tr><td>Total installed cost</td><td>XXXX</td><td>XXXX</td></tr>
<tr><td>Cost estimate accuracy</td><td>+/-26%</td><td>+/-26%</td></tr>
</table>

Table 16: Business case summary table

The preferred option (Option 1), will deliver reinforcements on all sites that have insufficient capacity as of 2019 and these capacity upgrades will be designed for a 2026 peak forecast demand. This option will deliver these upgrades within a 4-year programme, which provides an optimum balance between deliverability and capacity risk.

A reduced 2026 demand forecast (2019 to 2026 increase is 30% less) will have no impact on the required delivery costs in RIIO-2.

Our preferred option 1, delivers the capacity-upgrades at the following sites.

	EoE	Lon	NW	WM
Sites to be upsized (Option 1)	March (meter only) Maltby (meter only) Eye Green Offtake West Winch Offtake Teversham Westfield	None	Ashton Under Lyne Thornton Barrowford Longridge Road Hambleton PRI	Dawley (RIIO-1) Kinver

Table 17: Scope of preferred option 1.

Any further capacity-upgrades identified during RIIO-2, will be covered under a separate uncertainty mechanism discussed in Appendix 10.08 Reinforcements.

8. Preferred Option Scope and Project Plan

8.1. Preferred Option for this Request

Option 1 is to proactively upsize 10 AGI sites, upsize the metering systems at a further two AGIs sites and upsize one further AGI (a RIIO-1 project that requires construction in RIIO-2), as a 4-year programme.

This option addresses confirmed capacity issues with no risk of asset stranding.

We have strong evidence that the additional sites in Option 2 will emerge. However, given the uncertainty in any demand forecast, it is prudent for these items to be included within an uncertainty mechanism (see Appendix 10.08 Reinforcements).

8.2. Project Spend Profile

	21/22	22/23	23/24	24/25	25/26	Total
EoE						
NW						
Lon						
WM						
Total						

Redacted due to commercial sensitivity

Table 18: Proposed spend profile for RIIO-2: PRS Sites, Offtakes and Metering

8.3. Efficient Cost

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

More specifically for this investment case, we are confident that the costs provided in this investment case are efficient because:

- We have carried out a robust study to understand the asset components that are under capacity and have considered constructability and other site constraints to inform a robust scope of work.
- We have used current Cadent framework supplier rates for materials to inform the investment case.
- We have carried out a Peer Review with our Commercial and Capital Delivery team to validate the cost basis in the pre-feasibility study with RIIO-1 past projects.

Capacity Upgrades - > 7 bar reinforcements (AGIs) has various estimates of confidence stages. Some locations are further advance in design with some being at Conceptual Design and others being at Feasibility. When applying a weighted position our confidence is at Conceptual Design stage with a range of +/-26%.

8.4. Project Plan

As set out in the Option 1 summary, the different sites have been prioritised for delivery based on the level of risk to the security of supply.

Each site upsize is likely to take two calendar years to deliver. Year 1 will involve outline and detailed design and commercial negotiations to award a contract for construction. Construction and commissioning of the site will take place during year 2.

The following table shows the years each site will be commissioned.

	21/22	22/23	23/24	24/25	25/26
EoE	**March** (meter-only) HP – MP **Maltby** (meter-only) HP – MP	**Eye Green Offtake** NTS – HP **West Winch Offtake** NTS – HP	**Teversham** HP – HP **Westfield** HP - MP	-	-
NW	-	**Thornton** HP1 – HP2	**Barrowford** HP – MP **Longridge Road** HP – MP	**Hambleton PRI** HP – MP	-
Lon	-	**Woodford** HP – MP	-	-	-
WM	**Dawley** (designed RIIO-1) HP – MP	-	-	**Kinver** HP – MP	-
Total	**3**	**4**	**4**	**2**	**-**

Table 19: Proposed Project Plan

8.5. Key Business Risks and Opportunities

The key risks to the delivery of this programme are:

Reference	Risk Description	Impact	Likelihood	Mitigation /Control
09.23 - 001	Supply & Demand deliverability risk of Resource availability within the Gas industry	Potential cost increases in labour / commodity markets as demand is greater than supply	Low	Intelligent procurement and market testing. Apprenticeship and Training programmes to fill skills gaps
09.23 - 002	Stretching efficiency targets may not be deliverable (unit costs increase)	Outturn costs are not met increasing overall programme costs.	Low	Established marketplace - ability to manage the known commodity market
09.23 - 003	Unforeseen outages and failures restrict access for planned work	Programme and delivery slippage due to delay of planned outages and or site access	Low	Proactive asset management with ongoing condition surveys and response plans to prevent failures

09.23 - 004	Unseasonal weather in 'shoulder months', Autumn and Spring reduce site access/outage windows	Increased demands affecting access to sites and planned outages delay and cost increases	Low	Controlled forecasting and maintenance of flexibility to react to unforeseen events. Detailed design solutions to minimise outages and reduce exposure.
09.23 - 005	Unexpected / uncommunicated obsolescence during RIIO-2 period of equipment components	Inability to maintain equipment at full capacity with risk of impact upon supply	Low	Maintain a close relationship with equipment supply chain and manage a proactive early warning system where spares / replacements become at risk.
09.23 - 006	Legislative change - There is a risk that legislative change will impact the delivery of our work.	Potential increase in the amount of consultation and information exchange required and require us to align our plans with the safety management processes operated by 3rd Party landowner / asset owners. The potential impact is more engagement and slower delivery	Med	We have established management teams to address these issues. We have also identified UMs for key areas.
09.23 - 007	Demand does not increase in line with planned programme of works	Reduction in workloads impacting upon unit costs and volumes	Med	Continuing engagement with customer base and development plans to forecast future works
09.23 - 008	The ability for our operations teams to support the proposed programme of work	Delay and increase costs of delivery	Low	Ongoing engagement with Operations Planning and Asset teams
09.23 - 009	The ability for our supply chain to deliver this number of capacity upgrades in the first three or four years of RIIO-2	this could have an impact on unit-prices and may put up delivery prices as a result	Low	Maintain a close relationship with equipment supply chain and manage a proactive early warning system where delivery become at risk.
09.23 - 010	Upsizing our assets without any window for site outages	Inability to deliver upgrades to customers	Low	Ongoing engagement with Operations Planning, Land &

				Property and Asset teams
09.23 - 011	Where the existing sites are too small to allow for site rebuilds	Purchasing / renting sufficient land to enable construction cabins and site extensions	Med	Ongoing engagement with Operations Planning and Asset teams

Table 20: Risk Register

8.6. Outputs Included in RIIO-1 and RIIO-2 Plans

Although not identified as part of our RIIO-1 plan we are undertaking design work for investment at Dawley in 2020 to allow delivery in RIIO-2.

9.0 Regulatory Treatment

This investment will not be processed through the NARMs reporting tool.

Cost variance for low materiality specific projects such as this will be managed through the Totex Incentive Mechanism (TIM)

Additional work will be funded through the Reinforcement Uncertainty Mechanism Appendix 10.08.

This investment is accounted for in the Business Plan Data Table 3.01 LTS, Storage & Entry within the PRS Sub Table and the NTS Offtake Table under the Capacity Upgrades lines.

The work associated with metering for this investment line is included within the metering lines of table 3.01 LTS Storage and Entry within the PRS and the NTS Offtake Sub Tables.

Appendix 1. Summary of Findings from Pre-feasibility Study

Region	Site	Components under capacity	Key constraints/Issues	Recommended Scope
EoE	Eye Green Offtake	-Based on a desktop study, assumed to be similar to Euxton PRI	-	Following a desk-top review, the site was considered similar to Euxton PRI, which was studied in detail. Based on the Euxton PRI scope the following elements are assumed to require upgrade: • New filter & meter skid, two hot taps on site inlet / outlet. • Associated interconnecting pipework, civils and E&ICA works.
	West Winch Offtake	-Based on a desktop study, assumed to be similar to Barrowford.	-	Following a desk-top review, the site was considered similar to Barrowford with 25% uplift due to increased capacity. Based on the Barrowford scope the following elements are assumed to require upgrades to: • Filters, regulators, meters and preheater; hot taps on site inlet / outlet. • Associated interconnecting pipework, civils and E&ICA.
	Teversham	**HP – HP Stream.** • Pipework downstream of the pressure regulators to the outlet to Cambridge is undersized • Six DN80 Fisher 310 Pressure Regulators (three streams) **HP – IP Stream** has adequate capacity	Outage not available on HP-HP stream 4 months outage on HP – IP stream.	Upgrade capacity for the following assets on the HP – HP stream • Install six new DN100 pressure regulators, in situ. • Upsize inlet & outlet pipework; including hot tapping. • Associated civils and E&ICA works No upgrades required on HP - IP stream.
	Westfield	Pipework between heater to regulators Water Bath heater	No outage window Limited available land on site for	Because there is no outage window, a partial site rebuild is proposed comprising the following elements:

Region	Site	Components under capacity	Key constraints/Issues	Recommended Scope
		Regulators (Cadent Gas model suggests they are under capacity)	temporary site-cabins	• Heat-exchanger/boiler house (package preheat), associated water pipework, with upgraded power supply, instrumentation and control. • New regulator skid & building • New inlet / outlet connections and interconnecting pipework. • Additional land purchase for new heaters/regulators. • Civil works required to extend site (extensive groundworks due to topography and ground conditions).
NW	Ashton Under Lyne	• Outlet pipework after regulators • Heat exchanger • Meter	No outage window	To meet demand, a full site rebuild is required as there is no outage available, comprising following scope: • Filter & orifice-plate meter skid • Heat exchanger skid and associated water-pipework • Regulator skid • Interconnecting gas-pipework between inlet, outlet and each component. • Associated Elec and ICA equipment upgrades and civil works.
NW	Thornton	• DN150 filter inlet pipework • DN200 pipework downstream of 1st regulators • DN300 and DN450 pipework downstream of 2nd stage regulators • Filters • Heat exchanger and boiler house • Meter • Regulators	No outage window available	To meet demand, a new site rebuild is required: • New DN200 filter • New DN150 orifice meter skid • New DN150 heat exchanger skid • New regulator skid • Install new pipework connecting existing inlet to new skids to outlet section • Install new ducting and water pipes
	Barrowford	• Inlet pipework prior to filters • Filters • Heat exchanger and boiler house	No outage window	To meet demand, the following components need replacing/upsizing: • Inlet

Region	Site	Components under capacity	Key constraints/Issues	Recommended Scope
		• Meter • HP to MP regulators		• Filter and orifice meter skid • Heat exchanger skid and boiler house associated inter-connecting water pipework • New regulators within existing streams • New connections to inlet / outlet (hot tapping). • Associated Elec, ICA and civil works
	Longridge Road	• Outlet pipework • Heat exchanger & boiler house • Meter • Pressure regulators	2-month outage window	To meet demand, the following components need replacing/upsizing: • Orifice Meter • Heat exchanger skid & boiler house with associated inter-connecting water pipes • Regulator skid and associated housing. • Pipework connections to existing inlet and outlet. • Associated Elec, ICA and civil works
	Hambleton	Based on a desktop study, assumed to be similar to the full site rebuild option considered for Kinver		Following a desk-top review, the site was considered similar to the full site rebuild option for Kinver, which was studied in detail. Based on this option, the following elements are assumed to require upgrade: • New filters, meters, regulators, pre-heater / boiler house and hot taps on site inlet / outlet. • Associated interconnecting pipework, civils and E&ICA works.
Lon	Woodford	• Heat exchanger and boiler house • Meter	No outage available	As there is no outage available, the following is proposed to achieve the required capacity: • New DN150 orifice meter • New heat exchanger skid and 150kW boiler house, with associated water pipework • New regulator skid

Region	Site	Components under capacity	Key constraints/Issues	Recommended Scope
				• Associated civil works & Elec and ICA works.
WM	Dawley	RIIO-1 Site; detailed design due to start in 19/20.		
	Stratford Offtake	• Inlet pipework • Outlet pipework • Pressure Regulators • Heat exchangers and boilers	Extensive amount of interconnecting pipework under-sized.	To meet demand, the following components need replacing: • Filter & Meter skid • New heat exchanger & boiler house + associated inter-connecting water pipework • New regulator skid with associated building. • New interconnecting pipework between components; new connections to existing inlet and outlet pipework • Associated civil works & Elec and ICA works.
	Kinver	• DN80 pipework prior to regulators • DN150 outlet pipework • Meter • Regulators	5-month outage window	To meet demand, the following components need replacing: • Meter skid (insertion-meter type) • Filter and regulator skid • New DN250 outlet • Install new pipework from existing riser/pipework to new equipment to new outlet (outside of compound area) • Install new ducting

Table A1: Pre-feasibility Study

Appendix 2. Cost Breakdown for each Site Capacity Upgrade

The cost breakdown for each site is summarised below and is derived from engineering study.

Any sites without a detailed cost breakdown, have been estimated based on a desk-top exercise by our consultants, by comparing the site against a similar site with a detailed cost estimate to estimate a reasonable cost (3 out of the 13 sites and 34% of the total RIIO-2 capex forecast).

Cost Spilt - Scope Element (Pre-efficiency)	Eye Green Offtake*	West Winch Offtake	Teversham	Westfield	Ashton under Lyne
Engineering Design					
Materials					
Project Management					
Main Contractor Works					
Specialist Services (e.g. surveys, data, procurement)					
Vendor Package Costs					
Risk - Associated with delivering solution					
Contractor's Insurance & Fee					
Installed Cost					
Cost Estimate Uncertainty					
Engineering Total Installed Cost from Study (excluding contingency/Cadent costs)					
Cadent Contingency Costs (35%)					
Cadent Direct Costs (16%)					
Total Installed Cost					

Redacted due to commercial sensitivity

Cost Spilt - Scope Element (Pre-efficiency)	Thornton	Barrowford	Longridge Road	Hambleton	Woodford
Engineering Design					
Materials					
Project Management					
Main Contractor Works					
Specialist Services (e.g. surveys, data, procurement)					
Vendor Package Costs					
Risk - Associated with delivering solution					
Contractor's Insurance & Fee					
Installed Cost					
Cost Estimate Uncertainty					
Engineering Total Installed Cost from Study (excluding contingency/Cadent costs)					
Cadent Contingency Costs (35%)					
Cadent Direct Costs (16%)					
Total Installed Cost					

Redacted due to commercial sensitivity

Cost Spilt - Scope Element (Pre-efficiency)	Dawley	Stratford upon Avon Offtake	Kinver
Engineering Design			
Materials			
Project Management			
Main Contractor Works			
Specialist Services (e.g. surveys, data, procurement)			
Vendor Package Costs			
Risk - Associated with delivering solution			
Contractor's Insurance & Fee			
Installed Cost			
Cost Estimate Uncertainty			
Engineering Total Installed Cost from Study (excluding contingency/Cadent costs)			
Cadent Contingency Costs (35%)			
Cadent Direct Costs (16%)			
Total Installed Cost			

Redacted due to commercial sensitivity

Table A2: Cost Breakdown Per Site

Appendix 3. Cadent Licence Conditions

In line with Cadent's licence conditions,

"*the pipe-line system to which this licence relates (taking account of such operational measures as are available to the licensee including, in particular, the making available of stored gas) meets the peak aggregate daily demand, including, but not limited to, within day gas flow variations on that day, for the conveyance of gas for supply to premises which the licensee expects to be supplied with gas conveyed by it –*

(a) which might reasonably be expected if the supply of gas to such premises were interrupted or reduced as mentioned in paragraph 1(c); and

(b) which, (subject as hereinafter provided) having regard to historical weather data derived from at least the previous 50 years and other relevant factors, is likely to be exceeded (whether on one or more days) only in 1 year out of 20 years,

so, however, that if, after consultation with all gas suppliers, gas shippers and gas transporters, with the Health and Safety Executive and with Citizens Advice and Citizens Advice Scotland, the Authority is satisfied that security standards would be adequate if sub-paragraph (b) were modified by the substitution of a reference to data derived from a period of less than the previous 50 years or by the substitution of some higher probability for the probability of 1 year in 20 years, the Authority may, subject to paragraph 3, make such modifications by a notice which –

(i) is given and published by the Authority for the purposes of this condition generally; and

(ii) specifies the modifications and the date on which they are to take effect"

Cadent's policy for Network Planning (and agreed by The Gas Business Executive 09/02/1987) states that *"Regions should provide sufficient storage such that the expected ability to supply firm consumers is up to a level which would be exceeded one year in twenty on average, the provision of Regional transmission capacity and of Regional storage capacity being considered altogether."* The Gas Business Executive agreed this on 9th February 1987 (minute 182).