



Annex A14.04
King's Lynn Subsidence
Engineering Justification Paper
December 2019

As a part of the NGGT Business Plan Submission

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Name of Project	King's Lynn Subsidence		
Scheme Reference	TBC		
Primary Investment Driver	Asset Health		
Project Initiation Year	2022		
Project Close Out Year	2024		
Total Installed Cost Estimate (£)	£31.2m (18/19 price base) £█m (Baseline, FEED and tender event) £█m (construction of new pipework arrangement)		
Cost Estimate Accuracy (%)	P50		
Project Spend to date (£)	£0.5m (included in T1 baseline Asset Health)		
Current Project Stage Gate	4.1		
Reporting Table Ref	TBC		
Outputs included in RIIO-T1 Business Plan	No		
Spend apportionment	RIIO-1	RIIO-2	RIIO-3
	£0.5m	£31.2m	-

1 Project Status and Request Summary

- 1.1 National Grid are requesting funding to rebuild the bi-directional pipework arrangement at King's Lynn compressor site. This plant enables critical bi-directional capability for King's Lynn compression to meet entry and exit requirements at Bacton terminal including the interconnectors to Europe. This would cost £31.2m in RIIO-2 and consists of:
- £█m baseline funding for Front End Engineering and Design (FEED) study and tender event
 - £█m baseline variant for the removal of the existing area and construction of the new area
- 1.2 The £█m requested as baseline funding will be used to conduct an in-depth FEED study and tender event. We propose a PCD to measure our delivery of FEED in RIIO-2.
- 1.3 We are requesting baseline funding for the removal of the existing area and construction of the new area in our RIIO-2 plan. We are proposing to use a re-opener uncertainty mechanism post-FEED to adjust these costs and to define a new PCD for delivery of the final solution identified.
- 1.4 The bi-directional area has been affected by ground movement caused by subsidence and pipework is subject to unacceptable levels of stress with deformation of pipework and some instances of small gas escapes. During RIIO-1, we have

undertaken detailed investigations of the site and the pipework. We have been able to mitigate some risk by excavating and removing concrete from the pipework. An option has been considered to underpin (stabilise the ground) and repair the existing pipework but investigation of the ground conditions has not been able to find any supporting rock in the current location and has led to the rebuild option becoming the only feasible solution to ensure continued operation of this bi-directional facility in the long term. Doing nothing is not a viable option as the pipework is already overstressed and equipment will continue to sink into the ground leading eventually to failure of the pipework. Neither decommissioning the assets nor a uni-directional arrangement are viable options as they would restrict our ability to import/export gas through Bacton.

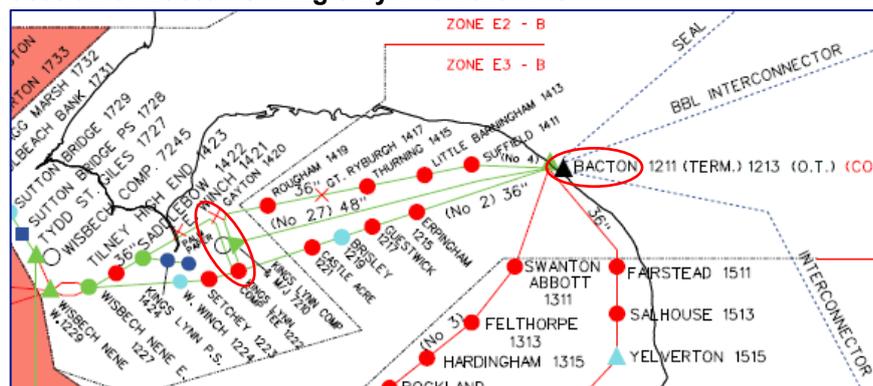
- 1.5 The work will be carried out during the RIIO-2 period. A high-level design has been developed and we have a plan for the work. The project will start in 2022 and will be completed in 2024.
- 1.6 Our Cost Benefit Analysis (CBA) calculates this work is cost beneficial.

2 Problem/Opportunity Statement

- 2.1 The purpose of this project is to address severe subsidence impacting the bi-directional pipework arrangement at King's Lynn compressor site. The subsidence is causing deformation to pipework and instances of leaks on small bore pipework have been recorded.
- 2.2 We became concerned in May 2011 that the bi-directional area was suffering from subsidence. Since then, actions to quantify and mitigate the risk have been implemented by identifying the level of pipe stress and helping to reduce that stress in the short term. Our Pipelines Maintenance Centre (PMC) excavated the area and found the ground to be of poor quality and unable to support the pipework. The drainage within the area was also found to be no longer functioning, failing to remove water from the area in a timely manner. During excavation works a large amount of concrete, remaining from the original construction, was found to be attached to some of the small pipework. This was placing extra stress on the pipework and has been removed.
- 2.3 In addition to the work carried out by PMC, engineering consultants Premtech have carried out stress analysis surveys throughout 2017 and 2018. The surveys have shown that most the pipework in the bi-directional area is suffering from an unacceptable level of stress. The bi-directional pipework arrangement has sunk over time meaning that the pipework has had to support itself rather than being supported by the soil. Most of the pipework was found to be over three times the acceptable stress level. This means it will weaken further over time with an increasing probability of failure and an uncontrolled gas escape. Isolation valves which will also facilitate replacement work were installed to enable isolation of the pipework in case of sudden ground movements.

- 2.4 The bi-directional pipework arrangement at King's Lynn is currently posing both a safety and a gas supply risk to the network for the following reasons:
- The potential for failure of pipework and/or fittings leading to an uncontrolled gas escape posing a significant safety risk to staff working on the site and members of the public
 - Any requirement to isolate this pipework will have a significant impact on the operation of the network, including loss of King's Lynn compression, entry and exit constraints at Bacton (including impact on the interconnectors) and wider network impacts including security of supply risks
- 2.5 The likelihood of these risks occurring will continue to increase if National Grid fails to address the issues with this site. The need to carry out this project becomes more urgent over time with increasing stress on the pipework.
- 2.6 King's Lynn compressor station provides the following critical functions on the network:
- Supporting the Bacton terminal exit flows through the interconnectors
 - Moving gas away from the South East when combined entry flows from the Bacton and Isle of Grain Terminals exceed local demand
- 2.7 The three feeders that pass through the bi-directional pipework arrangement represent three out of five feeders fed from Bacton Terminal (see figure 1). All three of the Feeders can be fed from Bacton, which is the largest entry and exit point in the UK. Over the past two years Bacton has at times provided up to 39% of the UK's gas need, on other occasions it has provided up to 30% of the system demand. Feeders 4 and 27 are unable to flow directly through the site without passing through the bi-directional pipework arrangement.

Figure 1: Location of Bacton & King's Lynn on the NTS



- 2.8 The bi-directional pipework arrangement at King's Lynn can be configured by opening and closing valves such that the compressor station "faces" either Bacton (East) or Wisbech (West) as required. Equalising balancing regulators connect the streams to balance pressure when changing flow direction.

- 2.9 The King's Lynn bi-directional pipework arrangement is crucial to the network all year round. Typically, it supports high entry flows in the summer and high exit flows in the winter. The bi-directional pipework arrangement provides a connection between feeders 2, 4 and 27. In addition to connecting the feeders it also acts as King's Lynn Compressors Station's connection point to the network. This allows King's Lynn Compressor Station to assist in moving gas eastward towards Bacton and the Interconnector or westward into the UK as required via one, two or all three feeders. The loss of the bi-directional pipework arrangement would restrict Bacton Terminal entry flows to one of the three feeders. In addition to the loss of feeders 4 and 27, feeder 2's flow capacity would be significantly reduced as King's Lynn Compressor would lose its connection to the network. This can be critical at very high levels of supply at Bacton; for example, the winter of 2017/18 saw supplies close to 140 mscm/d at Bacton which led to high running hours at King's Lynn.
- 2.10 The loss of the bi-directional pipework arrangement along with two feeders and King's Lynn compressor station would severely impact our ability to meet customers' entry and exit requirements, as well affecting our ability to meet UK gas demand. The need for the bi-directional functionality remains clear to support the bi-directional compressor requirements and the varying import and export flows.
- 2.11 We expect the 2030s to be a decade of key importance for King's Lynn. As shown in Figure 2 UK Continental Shelf (UKCS) supplies continue to decline and the UK becomes more reliant on imports via interconnectors and/or Liquefied Natural Gas (LNG). See Figure 3 for FES scenarios that show the net annual Bacton flows. The additional imports will result in higher net supplies into the South East during the winter, as the volume of gas entering the South East rises relative to demand. It will also result in higher net exports during the summer, as higher interconnector exports are required to support the return flows in winter coupled with a reduced offset of lower UKCS supplies.

Figure 2: Bacton Terminal UKCS Supplies

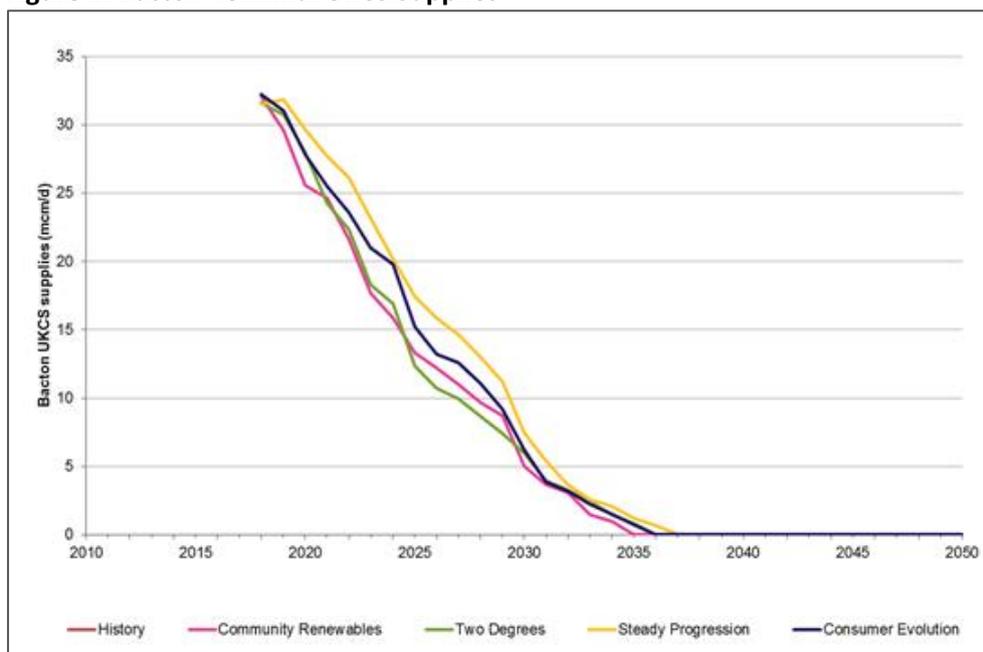


Figure 3: Bacton Peak Supply by Terminal, Steady Progression

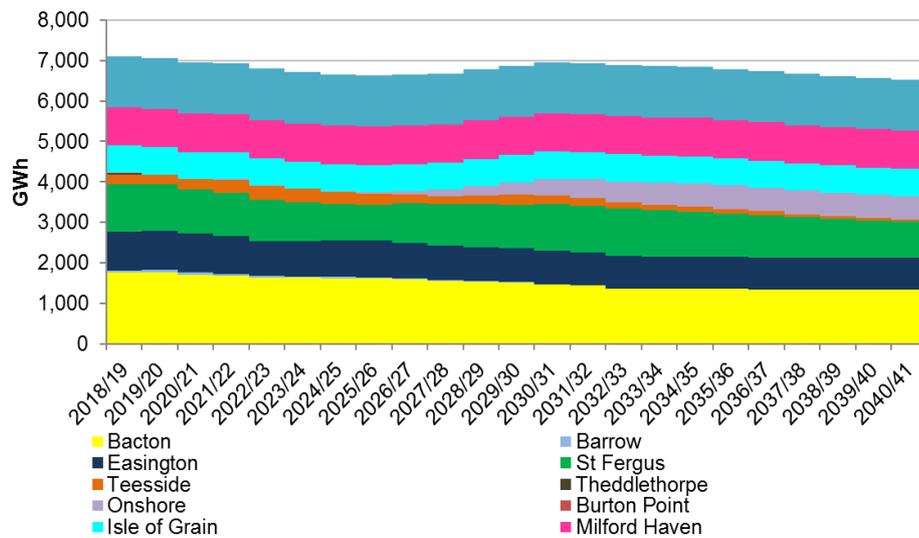
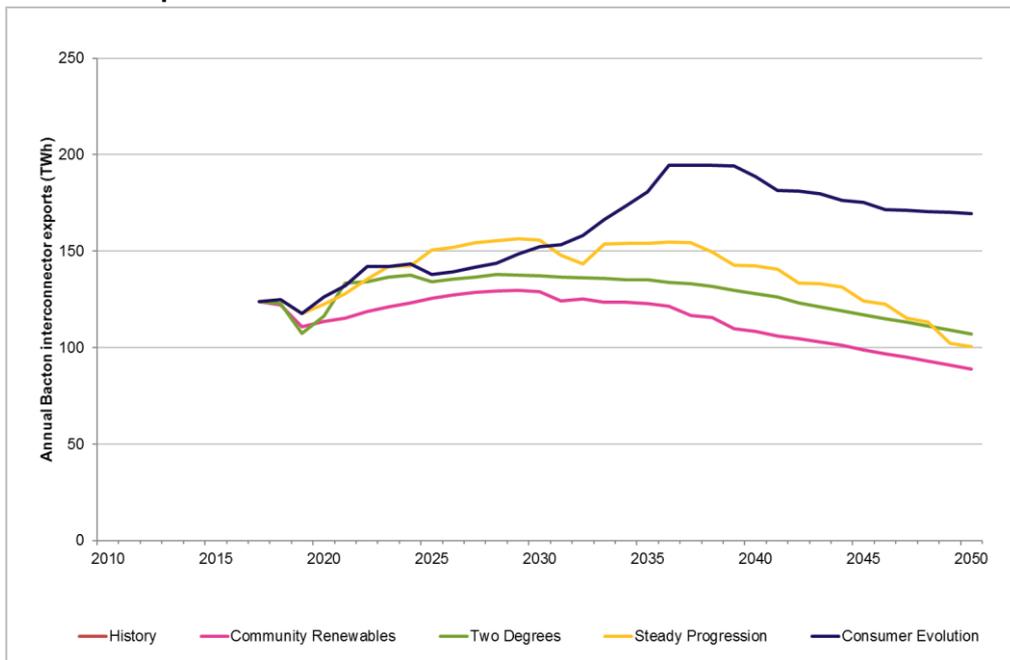


Figure 4: Bacton Exports under the FES Scenarios



2.12 Circumstances that could change the need or option for this project would result from changes to flow expectations at Bacton Terminal meaning less need for bi-directional flows between Bacton and King’s Lynn, such as:

- Changes in European markets reducing the import/export requirements.
- Changes in the interconnectors’ operating models or services affecting flows in and out of the UK
- Changes in gas quality limits that increase UKCS supplies affecting flows into the UK

- Changes in offshore operating models or new discoveries that increase UKCS supplies into Bacton changing flows into the UK.
- Demand in the South East is not expected to change significantly until at least 2040 with a mixture of interconnectors and LNG to meet exit obligations. Bacton will continue to act as a key node for managing this demand.
- Wider changes affecting GB gas demand or supply, such as an increase in shale gas or a move towards hydrogen beyond those included in our 2018 Future Energy Scenarios (FES impacting changing gas flows around the UK).

2.13 Having considered these risks, based on our forecasts there remains a requirement for the bi-directional capability.

2.14 Milestone dates have been informed by scheduling this project against other planned investment work. During the design and build phase there are five main milestones throughout the project shown in Table 1 below.

Table 1: Project phase and timeline

Phase	Timeline	Description
1. Feeder isolation	Q3 2022	Design and procurement of long lead items. Feeder 2 outage required. King's Lynn Tee to be piped through to enable isolation of the relevant section of pipework.
2. Construct bi-directional pipework	Q2 2023 - Q3 2023	New bi-directional pipework arrangement to be constructed from prefabricated sections. The construction work will require groundworks and installation of new supporting structures and pipework arrangements. Not outage dependent.
3. Dome ends	Q2 2023	The existing pipework will be capped by installation of dome end isolations. Outage required.
4. Interconnecting pipework	Q3 2023	The rebuilt (new) assets will be connected to the transmission system. Existing bi-directional pipework removed. Installation of interconnecting pipework between Feeders 2, 4, & 27, the new bi-directional arrangement, the scrubbers and compressor outlet.
5. Tie-ins	Q3 2023	Final tie-ins.

2.15 The project will be deemed a success once the new bi-directional area is operational and has achieved asset acceptance. The project will remove the existing bi-directional area assets and ensure that site ground works and drainage is satisfactory.

Related Projects

2.16 The King's Lynn compressor emissions compliance project is also scheduled to start in RIIO-2. Currently this is scheduled to commence after the bi-directional pipework arrangement re-build. The benefits are specifically related to the bi-directional area and excludes benefits associated with King's Lynn compression.

Project Boundaries

- 2.17 The project will not undertake work that is not associated with the bi-directional capability of the compressor site and not included within the scope of this project.

3 Project Definition

Supply and Demand Scenario Discussion and Selection

- 3.1 Bacton Terminal exports are expected to increase in all FES scenarios, as shown in Figure 3. In all but the Consumer Evolution scenario, this is sustained through the 2030s, after which the level of exports starts to decline. In the Consumer Evolution scenario, the increase is greater and more sustained, caused by rising gas demand in the 2040s. The bi-directional area at King's Lynn is key to facilitating these flows.
- 3.2 UKCS supplies at Bacton are forecast to decline in all FES scenarios and cease in the late 2030s. Although there is considerable uncertainty around UKCS supplies, it is clear, in the future the UK will be more reliant on imports via interconnectors and LNG. This will result in overall higher net supplies into the South East during winter and higher net exports during the summer, with a reduced offset of lower UKCS supplies at Bacton.
- 3.3 From our analysis of supply and demand scenarios, we have concluded that there is a long term need for a bi-directional flow capability at King's Lynn compressor. Without this capability, we will be unable to meet our customer's entry and export requirements, impacting the operation of the European interconnectors, limiting the UK's ability to import/export gas with continental Europe and risk not being able to meet UK gas demand.

Project Scope Summary

- 3.4 The King's Lynn bi-directional project will design, source materials and build a replacement bi-directional pipework arrangement.
- 3.5 The construction work will require groundworks and installation of new supporting structures and pipework arrangements. The interconnecting pipework will be diverted from the old and tied in to the new bi-directional area, with the old assets safely decommissioned. Alongside the construction of the new bi-directional area it will be important to remove all assets from the original bi-directional area. This will help to alleviate subsidence on site as well as reducing the risks to any further assets.
- 3.6 The new design will maintain the functionality of the existing arrangement, whilst also providing:
- Cross connections between the feeders 2, 4 and 27 without flow through the bi-directional pipework and therefore increasing operational resilience
 - The ability to isolate the compressor site from the network and therefore increasing operational resilience

- It will also remove all assets from the area of the current bi-directional area to alleviate the risk of further subsidence on site.

4 Options Considered

4.1 The table below shows the options that have been considered and the pros and cons are detailed in subsequent paragraphs and the options will be developed into a greater level of certainty as the project progresses through the investment process.

Table 2: Options Pros and Cons

Option	Benefits	Costs	Pros	Cons
Do Nothing	No additional funding would be required.	Zero	Zero Cost	<ul style="list-style-type: none"> • Fails to alleviate the subsidence issue • Pipework strain will remain at an unacceptable level • Safety (to staff and public) will become unacceptable • Risk to Bacton entry/exit capacity and wider network impacts - Over the past two years Bacton has at times provided up to 39% of the UK demand/import and up to 30% of export capacity
Underpin the current bi-directional area	Underpinning the current area may remove the requirement to build a new bi-directional area in the short term.	£5 million based on limited experience of underpinning. Costs could be much higher as stable ground has not been found and is likely to still result in rebuild option.	Potentially lower cost. Shorter initial project time, risk reduced / benefits realised earlier.	<ul style="list-style-type: none"> • The pipework has already suffered stress related damage which is irreversible • Unpredictable costs as this technique is unproven • Lengthy outages required resulting in network constraints (Bacton impact/export) • Sections of pipework may need to be repaired/replaced which is not included in cost • The underpinning work may not stop the subsidence and relieve the pipework stress
Build a new bi-directional area	This is the lowest risk option, providing a safe, reliable and resilient bi-directional capability at King's Lynn for 30 years plus.	£31.2 million	<ul style="list-style-type: none"> • Re-life the bi-directional area for another 30 years • Increased resilience through connection between feeders 2,4 and 27 • Remove the safety risk to staff and the public • Remove the network reliability risk • More predictable cost • Ground known to be more stable, previously siting a compressor 	<ul style="list-style-type: none"> • Potentially higher cost • Longer delivery programme • Time elapsed until we can mitigate this risk and realise the benefit
De-commission	Safety risk reduced	Not costed		<ul style="list-style-type: none"> • Entry and exit flows through Bacton remain restricted
Uni Directional Area (imports or exports)	Simpler to design and install	£15.8m + £3.1m to change direction	<ul style="list-style-type: none"> • Potentially lower cost in the short term 	<ul style="list-style-type: none"> • Loss of ability to support changing flow direction without significant intervention. Therefore risk of increased cost in the long term. • Risk of constraints in the event of unexpected changes in flows through Bacton.

First Option Summary (Do nothing)

- 4.2 The first option is to do nothing with the bi-directional area and attempt to maintain the current area without doing any works to stop further subsidence. This option is deemed to be unacceptable as the current bi-directional pipework is carrying too much stress and continues to deteriorate. We risk failure of the pipework, which poses a significant safety risk to site staff and the public, or being forced to isolate the pipework meaning loss of bi-directional capability and significant impact on Bacton entry and exit capability including reducing the flow through the interconnector.

Second Option Summary (Underpinning)

- 4.3 This option attempts to underpin the existing bi-directional area. However, the underpinning technique is not guaranteed to stop the subsidence. During the investigation works carried out by Premtech, three boreholes were drilled to a depth of fifty metres showing very poor ground structure to a significant depth. This means that any underpinning work would have to go to a very large unknown depth in order to find firm bed rock to act as a base for the underpinning. This will add additional cost to the work. Without taking this action the chance of the underpinning failing is more likely.
- 4.4 In addition, the bi-directional area pipework has already been placed under significant stress with the surveys showing sections of the pipework over three times the acceptable stress levels. The underpinning will not reverse the damage that has already been caused and some sections of the bi-directional pipework will have to be replaced regardless, incurring additional and currently unknown costs. Currently the amount of pipework that would have to be removed and replaced as part of any repair requires confirmation once the area has been stabilised and an outage would be required during the repair work disrupting supplies. However it is likely to be a significant part of the pipework arrangement based on the stress surveys already carried out by Premtech.
- 4.5 This option, offers no guarantees of resolving the problem or reducing the risk of failure. There is a significant risk that costs will increase as the solution fails to address the problem and ultimately, we may need to resort to the rebuild option in order to ensure the ongoing safety and reliability of a key installation on the NTS. In addition to the escalating cost and risk level, ongoing work will require longer outage durations.
- 4.6 We do not believe that this is a feasible option for efficiently ensuring safe and reliable operation of the bi-directional area.

Third Option Summary (Rebuild AGI)

- 4.7 This option is to construct a new bi-directional pipework arrangement within the boundaries of King's Lynn compressor site. A new bi-directional area will remove the current risk both in terms of safety (to site staff and the public) and deliver a reliable bi-directional capability to support entry and exit capacity at the Bacton terminal site into the future.

- 4.8 The new design will also provide increased resilience (at no extra cost) by providing a connection between feeders 2,4 and 27 without flowing through the bi-directional pipework, as well as allowing the compressor site to be isolated from the network.
- 4.9 This is our recommended option as we believe it represents the lowest overall risk in terms of cost certainty and continued availability of this critical network capability. However, we will continue to review options ahead of our final submission to ensure that we deliver the option in the best interests of consumers.

Fourth Option Summary (Decommissioning)

- 4.10 Decommissioning the assets has been considered as an option and discounted. This has the same effect as the “do nothing option” in that it will restrict the entry and exit capacity at Bacton, but the removal of the assets is done in a controlled and safe way rather than risking failure.

Fifth and Sixth Options Summary (Uni Directional Area)

- 4.11 A uni-directional arrangement has been considered whereby the gas can only flow in one direction East or West requiring significant intervention to change the direction of the valve arrangement. This option has been discounted as the unidirectional option limits imports from Bacton, if the flow was going West to East. This could impact the network security of supply by limiting the availability of continental and UKCS imports to respond if LNG supply is not available. If the flow was going from East to West the ability to export gas through the interconnector would be seriously hampered.
- 4.12 In addition, there may be the option to have the uni-directional arrangement facing in one direction and then at a point appropriate in the future the inputs and outputs could be changed allowing for flow in the opposite direction. It is important to note that this could only be done once.

Options Cost Estimate Details

- 4.13 The cost associated to the above options are listed in Table 3 below. It is important to note that at this stage of the investment process the current costs are initial estimates based on our unit cost model. The unit cost model gives a cost per item and those costs are then multiplied by the number of items required. The unit cost module has been developed by calculating an average cost per item from National Grid’s purchase history converted into 2018/19 prices. The final cost will be finalised during the design and tender phase of the project.

Options Summary

4.14 The options costed are set out in Table 3 below.

Table 3: Options Summary

Option title	Project start date	Project commissioning date	Project design life	Operating cost	Total installed cost	Cost estimate accuracy (%)
Do Nothing	R110-1	R110-1	N/A	0	£0	N/A
Underpin	R110-1	R110-2	Unknown	Unknown	£5m *	Low
Rebuild	R110-1	R110-2	30 years +	0	£31.2m	P50
Decommission	R110-1	R110-2	0	Not costed	Not costed	N/A
Uni Directional (imports and exports)	R110-1	R110-2	30 years +	Not costed	£15.8m + £3.1m to change direction	N/A

*significant cost uncertainty exists with Underpinning option as set out in paragraphs 4.3-4.6

5 Business Case Outline and Discussion

Key Business Case Drivers Description

- 5.1 The Cost Benefit Analysis (CBA) has been carried out with NPV for each option shown in Table 4.
- 5.2 The key drivers for this investment are:
- Safety risk to site staff and the public through failure off pipework or fittings leading to an uncontrolled gas escape
 - Environmental risk of a large release of gas resulting from failure of pipework and the consequential venting operation to isolate and make safe
 - Availability risk of impacting Bacton entry and exit capability

Supply and Demand Scenario Sensitivities

- 5.3 We do not believe that changes in supply and demand scenarios significantly impact the need for this investment. The need for the bi-directional capability of King's Lynn compressor station is predicated on the requirement to have both import and export capability at Bacton. Across all supply and demand scenarios, there is an expected increase in interconnector flows at Bacton.

Business Case Summary

- 5.4 The table below shows the costs of considered options based on the project without any additional unforeseen Asset Health work. The lead option is 'rebuild', which has a positive NPV of £499m relative to the 'Do nothing' case. This is due to the impact of losing compression and import and export capacity at Bacton in the event of a loss of the bi-directional area. Any benefits associated specifically with the King's Lynn compressors are excluded.

Table 4: Option Costs and NPV¹

Desc. Of Option	Preferred Option	Total Forecast Expenditure (£m)	Total NPV (£m)	Delta (option to baseline) (£m)
0 – Do Nothing	N		-£526.41	
1 – Rebuild	Y	-£31.22	-£27.63	£498.78
2 – Underpin	N	-£5.00	-£195.55	£330.86
3 – Uni Directional	N	-£ 15.83	-£19.25	£507.16
4 – Uni Directional / Flip 2040	N	-£18.94	-£22.49	£503.92

- 5.5 This CBA calculates that it is cost beneficial to undertake this investment. The underpinning option carries a large amount of uncertainty with it, as explained in 4.3-4.6. It is however, understood that these costs carry a degree of uncertainty due to the project stage they are in (Stage 4.1). Therefore, it is proposed that all funding for the redeveloped terminal, excluding funding to conduct a detailed FEED study and tender exercise, should be subject to a baseline variant funding mechanism. This will be triggered via a reopener following FEED, to ensure the most efficient cost to the consumer.
- 5.6 The rebuild option carries a certain amount of uncertainty, the cost has been based on the CBA using a unit cost model. The unit cost model has been based on an average of National Grid past purchase history of individual items, this has then been converted into 2018/19 costs. The final cost will more accurately calculate after the completion of survey and design phase.

Sensitivity to FES scenarios

- 5.7 We have undertaken sensitivity analysis against the four FES scenario’s to assess the NPV of the options at King’s Lynn compared to the “do nothing” option. The results are shown in Table 5.
- 5.8 In two of the FES scenario’s, ‘Community Renewables’ and ‘Two Degrees’ the rebuild (bi-directional capability) option is the most cost beneficial relative to the other options. This is due to the high levels of gas imports in these scenarios.
- 5.9 In the other two FES scenario’s, ‘Slow Progression’ and ‘Consumer Evolution’ the unidirectional option is the most cost beneficial option relative to the other options but there is only a relatively marginal benefit over the rebuild option. This analysis does not consider the detrimental impact a unidirectional solution could have on GB security of supply (e.g. by limiting ability of continental imports if LNG was not available).

¹ Note that these calculated NPVs assume a capitalisation rate of 73.5%. This capitalisation rate has now been updated, and therefore there may be a minor mismatch between quoted NPVs between this document and the associated CBA (Annex A14.05). Please note that this does not affect the final proposed option. The impact of the updated capitalisation rate is reflected in the CBA document

Table 5: FES scenario sensitivities

Short Name	NPV ² £m	Central Case (Slow Progression)	Two Degrees	Community Renewables	Consumer Evolution
		Relative NPV (£m)	Relative NPV (£m)	Relative NPV (£m)	Relative NPV (£m)
0 - Do Nothing	-£526.4 m				
1 - Rebuild	-£27.6 m	£498.8 m	£878.6 m	£165.6 m	£2207.6 m
2 - Underpin	-£195.6 m	£330.9 m	£102.7 m	£64.0 m	£256.2 m
3 - Uni Directional	-£19.2 m	£507.2 m	£140.0 m	£61.6 m	£2221.2 m
4 - Uni Directional / Flip 2040	-£22.5 m	£503.9 m	£635.4 m	£80.9 m	£1687.8 m

6 Preferred Option Scope and Project Plan

Preferred Option for this Request

6.1 The most effective and low risk option for ensuring continued safe and reliable provision bi-directional capability at King’s Lynn compressor station is to rebuild the area in a different section of the compressor site. The construction work would take place away from any live pipework, alleviating the risk of modifying/repairing the current bi-directional pipework. It is important to note that the King’s Lynn bi-directional area is complex with three feeders feeding into one arrangement in addition to the compressor connection to the network. As a result, the construction of the new arrangement is forecast to cost £31.2m in RIIO-2 and consists of:

- £█ m baseline funding for Front End Engineering and Design (FEED) study and tender event
- £█ m for the removal of the existing area and construction of the new area
- Continue the cross connections between the feeders 2, 4 and 27 without flow through the bi-directional pipework and therefore increase operational resilience
- Create the ability to isolate the compressor site from the network and therefore increase operational resilience
- It will also remove all assets from the area of the current bi-directional area to alleviate the risk of further subsidence on site

Project Spend Profile

6.2 Table 6 shows the project spend profile. Note that this profile of spend reflects the latest view of our proposed RIIO-2 investment at King’s Lynn and does not change the total spend for this project.

² Note that these calculated NPVs assume a capitalisation rate of 73.5%. This capitalisation rate has now been updated, and therefore there may be a minor mismatch between quoted NPVs between this document and the associated CBA (Annex A14.05). Please note that this does not affect the final proposed option. The impact of the updated capitalisation rate is reflected in the CBA document

Table 6: Spend profile

Year	2022	2023	2024	2025
Capex	m	m	m	m

Efficient Cost

6.3 The cost of for the rebuild has been calculated using a unit based cost model, which has arrived at £31.2m total. Several factors should be considered to allow the greatest financial and project delivery efficiencies:

- Early purchase of long lead items, e.g. valves and actuators
- Construction of plant to be carried out away from site where possible
- Early interactions with site operational teams to alleviate any unforeseen risks and delays in the project
- Efficient project management ensuring the timely delivery of the project.

Project Plan

5.10 Table 7 shows the keys tasks to be completed through the project along with the start and finish dates of those tasks.

Table 7: Project plan

Key Tasks	Start date	Completion date
Survey	June 2021	Sept 2021
Detailed design	Sept 2021	March 2022
Purchase long lead items	Sept 2021	March 2022
Prelims & Fabrication	March 2022	October 2022
Proposed outage	March 2023	Sept 2022
Construction	May 2023	Sept 2023
Completion	Sept 2023	December 2023
Closure of Project	December 2023	March 2024

Key Business Risks and Opportunities

5.11 In the unexpected event that the subsidence does not get any worse, a significant part of the bi-directional pipework still requires repair to address the existing faults and ensure safe and reliable operation.

5.12 Key project risks include:

- Outcomes from the tender process which may influence the design and configuration of the new bi-directional pipework
- Site ground conditions, such as, onsite drainage and unknown buried assets, limiting options and incurring additional costs

- Unplanned Outages, the unpredictability of customer flows or other unplanned outages on the network meaning that planned outages cannot always be agreed leading to constraint risk;
- The build will be taking place on a live site so the project team must liaise with Operations to ensure safe construction with minimal impact on routine activities
- The planned location for the new bi-directional pipework arrangement is on a part of the site which was previously home to a compressor unit. The unit was decommissioned some time ago but the concrete slab base still exists. The ground must be carefully surveyed to ensure its suitability and there is a likelihood of buried abandoned pipework that will have to be removed before construction work can start.

Outputs included in RIIO-T1/T1 Plans

5.13 There are no outputs included in our RIIO-1 plans. Our NOMs model does not identify this a risk and the asset is not at the end of its theoretical technical asset life. We have incurred expenditure in RIIO-1 to mitigate the risk and support the ongoing operation of the assets and maintain functionality with the minimum investment.

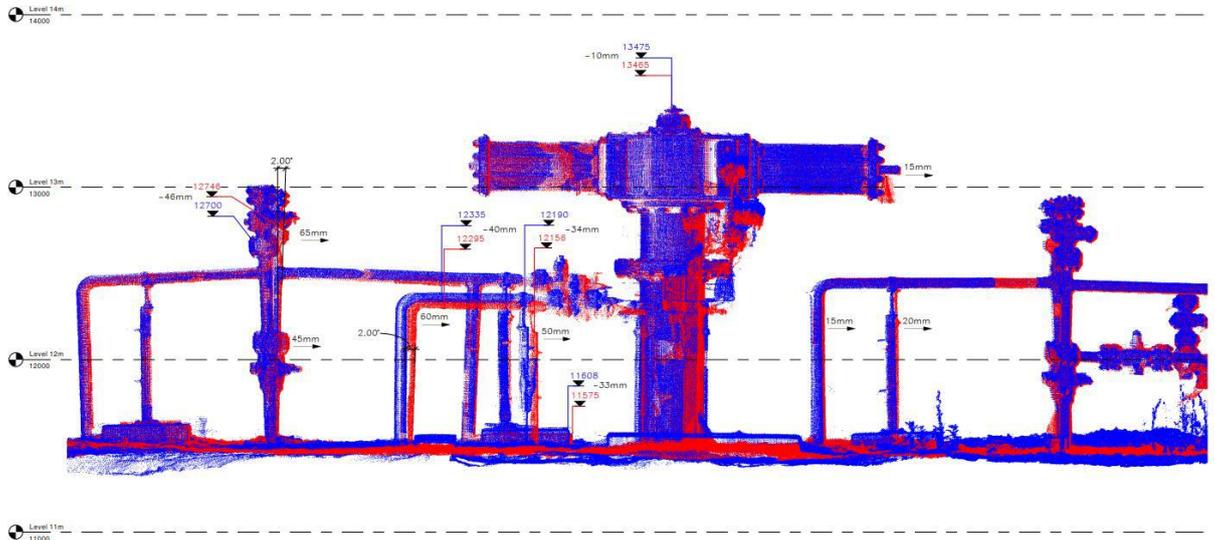
Appendix

1. Image of King's Lynn Compressor Stations showing the current bi-directional area and the preprocessed new area



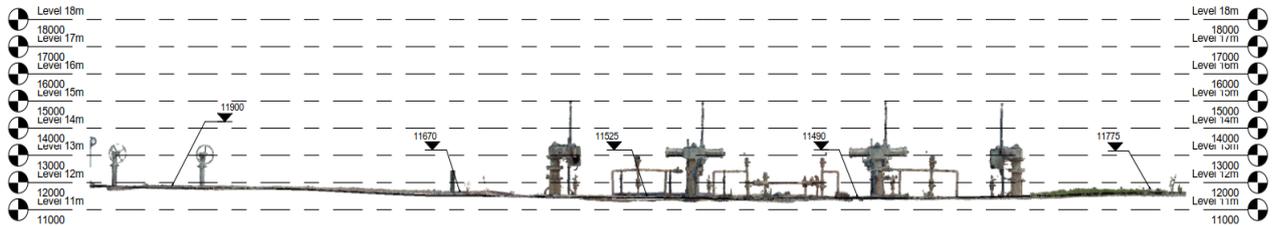
2. The Below diagram show the movement in above ground pipe between 2017 and 2018 (blue shows the original reading and red the later readings).

ELEVATION ON VALVE 721011
SCALE: 1:10



3. The below diagram shows the ground levels recorded in 2017

Kings Lynn North-South Section



Kings Lynn East-West Section

