

King's Lynn Compressor Emissions – Final Preferred Option

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We are consulting on our Final Preferred Option for investment at the King's Lynn Compressor Station to ensure compliance with the Medium Combustion Plant Directive. We are seeking views from all interested stakeholders in particular, network companies, gas shippers, consumer groups, environmental groups, and the public. This document sets out our proposed Final Preferred Option and seeks responses to several specific questions. The responses we receive will be considered before our final decision is issued.

We want our consultations process to be transparent. So we intend publishing the non-confidential responses received on our website at [Ofgem.gov.uk/consultations](https://www.ofgem.gov.uk/consultations) along-side our decision. If you want your response – in whole or in part – to be considered confidential, please tell us and explain why. Please clearly mark the parts of your response that you consider to be confidential, and if possible, put the confidential material in separate appendices to your response.

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Executive summary

King's Lynn Compressor Emissions - Final Preferred Option

In our RII0-T2 Final Determinations we accepted the 'needs case' for investment at the King's Lynn Compressor Station to ensure compliance with the Medium Combustion Plant Directive. The Directive requires that by 1st January 2030 the Nitrogen Oxide (NO_x) emissions of all gas turbines with a net thermal input of between 1MW and 50MW, do not exceed 150mg/m³.

However, given the level of uncertainty at the time with respect to both the 'preferred option' and the level of funding required, we decided that this and other similar Compressor Emissions projects, should be funded through our Gas Transmission Project Assessment Process. This two stage process is set out in Special Condition 3.11 Compressor Emissions Re-opener and Price Control Deliverable.

At Final Determinations we provided £14.38m (2018/19 prices) of baseline funding in the form of a Price Control Deliverable for the King's Lynn Compressor Station project. The required deliverables were a Final Option Selection Report in January 2023 followed by a Re-opener application seeking a funding direction in April 2025. The Final Option Selection Report must contain a Final Preferred Option along with supporting evidence necessary for the Authority to either accept the Final Preferred Option or approve an alternative as the Final Preferred Option, reject the Final Preferred Option on the basis that no further work should go ahead or ask for more information. The Re-opener application must be based on the Final Preferred Option approved by the Authority.

In compliance with Special Condition 3.11, National Gas Transmission submitted a Final Option Selection Report in January 2023. This identified the Final Preferred Option as being the replacement of the existing Avon with a new unit by 2028 on the existing site. Eight options including the counterfactual 'do nothing' were shortlisted with the Final Preferred Option identified using a Cost Benefit Analysis, Best Available Technology assessment and several security of supply case studies.

Having considered the evidence presented in the Final Option Selection Report, we propose rejecting the Final Preferred Option identified in the report and instead approving one of the other shortlisted options. Our proposed Final Preferred Option is the counterfactual 'do nothing', with the existing Avon retained under the 500-hour Emergency Use Derogation allowed for in the Directive, with significant asset health investment to improve unit

availability. To ensure operation mapping alignment across all site compressors, this option will also consider the case for a re-wheel of the existing SGT-400s during the next phase of the project.

Separately, should National Gas Transmission identify a cost effective retrofit that will permit unrestricted operation of the existing Avon, then we would expect National Gas Transmission to implement that solution and seek funding as part of the next price control

Next Steps

We welcome responses to our consultation, in particular to the specific questions we have included in Chapters 4 and 5. Please send your response to: graham.craig@ofgem.gov.uk by 14 July 2023. We expect to publish our decision on the Final Preferred Option no later than 3 November 2023.

1. Introduction

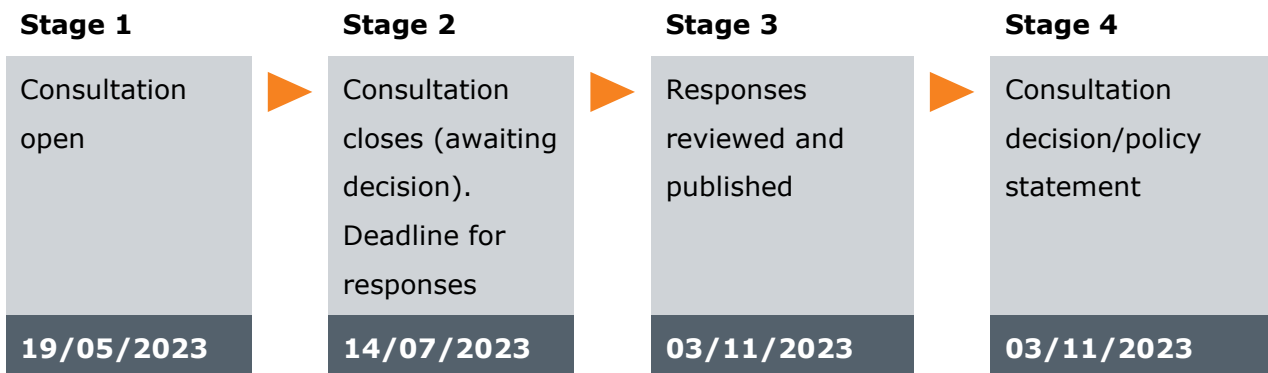
What are we consulting on?

1.1. This consultation sets out our minded to position not to approve the Final Preferred Option identified by National Gas Transmission in the King’s Lynn Compressor Emissions Final Option Selection Report (replacement of the existing Avon with a new unit) but to approve one of the other shortlisted options as the Final Preferred Option (retention of the existing Avon under the 500-hour Emergency Use Derogation).

1.2. This consultation sets out our assessment of the evidence presented in the Final Option Selection Report and the various factors we have considered when reaching our minded to position. We are seeking views from interested stakeholders on our assessment of the evidence and our minded to position as to the Final Preferred Option.

Consultation Process

1.3. Figure 1 shows the stages of this consultation process:



How to respond

1.4. We want to hear from anyone interested in this consultation. Please send your response to the person or team named on this document’s front page. We have asked for your feedback in each of the questions throughout. Please respond to each one as fully as you can. We will publish non-confidential responses on our website at www.ofgem.gov.uk/consultations.

Your response, data and confidentiality

1.5. You can ask us to keep your response, or parts of your response, confidential. We will respect this, subject to obligations to disclose information, for example, under the Freedom of Information Act 2000, the Environmental Information Regulations 2004, statutory directions, court orders, government regulations or where you give us explicit permission to disclose. If you do want us to keep your response confidential, please clearly mark this on your response and explain why.

1.6. If you wish us to keep part of your response confidential, please clearly mark those parts of your response that you *do* wish to be kept confidential and those that you *do not* wish to be kept confidential. Please put the confidential material in a separate appendix to your response. If necessary, we will contact you to discuss which parts of the information in your response should be kept confidential, and which can be published. We might ask for reasons why.

1.7. If the information you give in your response contains personal data under the General Data Protection Regulation (Regulation (EU) 2016/679) as retained in domestic law following the UK's withdrawal from the European Union ("UK GDPR"), the Gas and Electricity Markets Authority will be the data controller for the purposes of GDPR. Ofgem uses the information in responses in performing its statutory functions and in accordance with section 105 of the Utilities Act 2000. Please refer to our Privacy Notice on consultations, see Appendix 4.

1.8. If you wish to respond confidentially, we will keep your response itself confidential, but we will publish the number (but not the names) of confidential responses we receive. We will not link responses to respondents if we publish a summary of responses, and we will evaluate each response on its own merits without undermining your right to confidentiality.

General feedback

1.9. We believe that consultation is at the heart of good policy development. We welcome any comments about how we have run this consultation. We would also like to get your answers to these questions:

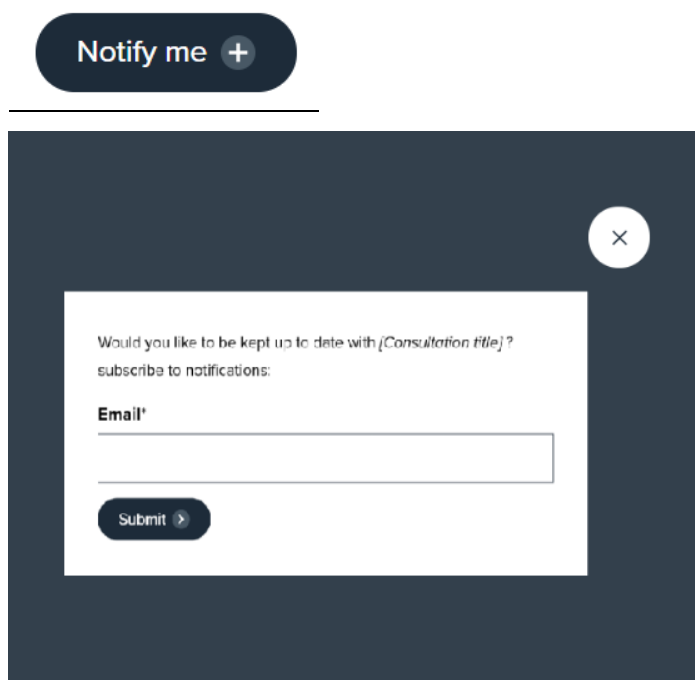
1. Do you have any comments about the overall process of this consultation?
2. Do you have any comments about its tone and content?
3. Was it easy to read and understand or could it have been better written?
4. Were its conclusions balanced?
5. Did it make reasoned recommendations for improvement?
6. Any further comments?

Please send any general feedback comments to stakeholders@ofgem.gov.uk

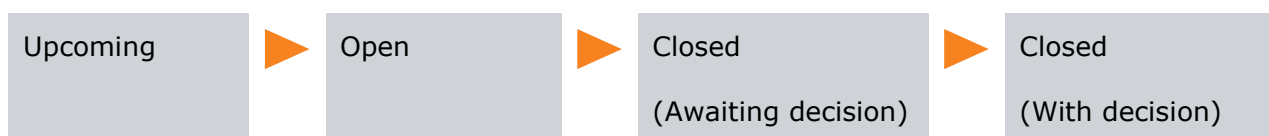
How to track the progress of the consultation

You can track the progress of a consultation from upcoming to decision status using the 'notify me' function on a consultation page when published on our website.

[Ofgem.gov.uk/consultations](https://www.ofgem.gov.uk/consultations).



Once subscribed to the notifications for a particular consultation, you will receive an email to notify you when it has changed status. Our consultation stages are:



2. Compressor emissions Re-opener and Price Control Deliverable mechanism

Section summary

This Chapter gives an overview of the RIIO-2 Re-opener mechanism and our assessment process.

Overview of the RIIO-2 Re-Opener mechanism

2.1. The gas transmission network in Great Britain is owned and operated by National Gas Transmission. Economic regulation of the network follows the RIIO (Revenue = Incentives + Innovation + Outputs) price control framework. The current RIIO-T2 price control period will last five years from 1 April 2021 to 31 March 2026. Prior to commencement of the price control period, we set out in our Final Determinations¹ our policy on the economic regulation of the network during the period. These policy decisions were given effect by new Special Conditions in Part C of the National Gas Transmission gas transporter licence, which came into force on 1 April 2021.

2.2. In our RIIO-T2 Final Determinations we accepted the 'needs case' for investment at a number of sites on the network, including King's Lynn Compressor Station, to ensure compliance with the Medium Combustion Plant Directive. The Directive requires that by 1st January 2030 the Nitrogen Oxide (NOx) emissions of all gas turbines with a net thermal input of between 1MW and 50MW, do not exceed 150mg/m³.

2.3. However, given the level of uncertainty at the time with respect to both the 'preferred option' and the level of funding required, we decided that this and other similar Compressor Emissions projects should be funded through our Gas Transmission Project Assessment Process. This two stage process is set out in Special Condition 3.11 (Compressor Emissions Re-opener and Price Control Deliverable).

¹ [Final Determinations - NGGT Annex Revised \(10\).pdf](#)

2.4. At Final Determinations we provided £14.38m (2018/19 prices) of baseline funding in the form of a Price Control Deliverable for the King’s Lynn Compressor Emissions project. The required deliverables were a Final Option Selection Report in January 2023, followed by a Re-opener application seeking a funding Direction in April 2025. The Final Option Selection Report must contain a Final Preferred Option along with supporting evidence necessary for the Authority to either accept the Final Preferred Option, approve an alternative as the Final Preferred Option, reject the Final Preferred Option on the basis that no further work should go ahead or ask for more information. The Re-opener application must be based on the Final Preferred Option approved by the Authority.

2.5. Special Condition 9.4 requires that all Re-opener applications must be prepared in accordance with our Re-opener Guidance and Application Requirements Document.² This includes guidance on the preparation of Engineering Justification Papers and Cost Benefit Analysis, which are the key tools we expect to be used in the identification of a ‘preferred option’.

2.6. In addition, we have published an Indicative Re-opener Application Assessment Process.³ This working document sets out an indicative process for dealing with Re-opener applications

2.7. In January 2023, consistent with Special Condition 3.11, National Gas Transmission submitted a Final Option Selection Report for investment at King’s Lynn Compressor Station to ensure compliance with the Medium Combustion Plant Directive. In accordance with our indicative application assessment process, having determined that a valid submission had been submitted, we proceeded to a detailed assessment of the Final Option Selection Report and the Final Preferred Option. We made our determination on the validity of National Gas Transmission’s submission because it was submitted⁴

- Compliant with the requirements set out in Special Condition 3.11.8

² [RIIO2 Re-opener Guidance and Application Requirements Version 2.0 | Ofgem](#)

³ [RIIO-2 indicative Re-opener application assessment process: working document | Ofgem](#)

⁴ King’s Lynn Compressor Emissions FOSR submission in January 2023 - Appendix J – Mapping of Ofgem Requirements

-
- Compliant with the requirement set out Special Condition 9.4.3 to prepare the submission in accordance with our Re-opener Guidance and Application Requirements Document.
 - Compliant with the requirement set out in our Price Control Deliverable Reporting Requirements and Methodology Document (Appendix 5).⁵
 - Published on the NGGT website within five working days of submission with any redactions in line with our Re-opener Guidance and Application Requirements Document.⁶
 - Accompanied by a letter of assurance that met the requirements set out in our Re-opener Guidance and Application Requirements Document⁷.

⁵ [Price Control Deliverable Reporting Requirements and Methodology Document | Ofgem](#)

⁶ [Our RIIO-2 re-opener applications \(2021-2026\) | National Grid Gas](#)

⁷ King's Lynn Compressor Emissions FOSR submission in January 2023 - Appendix I Assurance Letter

3. King's Lynn Compressor Emissions Final Option Selection Report

Section summary

This chapter summarises the option selection process set out in the Final Option Selection Report submitted by National Gas Transmission.

Context

3.1. The Medium Combustion Plant Directive requires that by 1st January 2030 any gas turbines with a net thermal input between 1MW and 50MW must not exceed a Nitrogen Oxide (NOx) emissions limit of 150mg/m³.

3.2. King's Lynn Compressor Station is the sole source of compression required to facilitate the export and import of gas through the two interconnectors between Great Britain and Europe at the Bacton Terminal. King's Lynn therefore has a critical role in providing security of supply for energy consumers in Great Britain. King's Lynn Compressor Station currently operates three gas turbine driven compressor units, one of which, the Siemens Avon, is not compliant with the Directive. A decision is required as to the future of the Avon post 1 January 2030.

3.3. The Final Option Selection Report aligns with the Compressor Emissions Asset Management Plan (CE-AMP) published by National Gas Transmission. It summarises the various options available and considers each using several standard assessment tools.

King's Lynn Compressor Station

3.4. King's Lynn Compressor Station comprises three operational gas turbine - driven compressor units. One Siemens Avon (Unit B) and two SGT400s (Units C and D). The Siemens Avon (Unit B) is not compliant with the Medium Combustion Plant Directive. There is a fourth non-operational compressor unit (Unit A), which has been disconnected and is due for decommissioning. Table 1 below summarises the key features of the compressor units at King's Lynn.

Unit	Engine	Fuel	Power Base (MW)	Installed	Minimum Operational Flow (mscm/d)	Nominal Capacity (mscm/d)
A Disconnected	Avon	Gas	12.34	1971	13	56
B	Avon	Gas	12.34	1971	9	56
C	SGT400	Gas	12.9	2000	15	42
D	SGT400	Gas	12.9	2003	16	42

Table 1 – King’s Lynn Compressor Units

3.5. The scheduled re-wheeling of the two SGT400s (Units C and D) will align their operational envelopes with current flows, allowing them to take over the primary duty role by 2030. These two units, operating either separately or in parallel, will be capable of providing the required level of compression at King’s Lynn. A third unit would (1) in the case of Unit B being retained, provide back-up should either of the SGT400s be unavailable (2) in the case of Unit B being replaced, supersede one of the SGT400s as lead with the other becoming a back-up unit.

Option Selection Process & Cost Benefit Analysis

3.6. National Gas Transmission considered a complete suite of solutions to enable compliance with the Directive. The high-level options considered included:

- Doing nothing to reduce Unit B emissions (counterfactual), with the unit operated under the Emergency Use Derogation (EUD) i.e. limited to 500 run hours per year beyond 2030
- Retrofitting of Unit B with emissions abatement technology to enable compliance - Control System Restricted Performance (CSR), Dry Low Emissions (DLE) and Selective Catalytic Reduction (SCR)⁸
- Replacement of Unit B with a new low-emission/ high efficiency unit
- Decommissioning of Unit B

⁸ King’s Lynn Compressor Emissions FOSR submission in January 2023 - CSR Performance Testing Report, Avon DLE Test Report, SCR Technical Feasibility Study

3.7. Table 2 below summarises the eight shortlisted options considered in the Final Option Selection Report.

Option Shortlist	Unit A	Unit B	Unit C	Unit D	Unit E	Unit F
1 – Counterfactual	Disconnected	500Hr EUD	Compressor Re-Wheel	Compressor Re-Wheel	/	/
2 - 1 x CSRP	Disconnected	CSRP Retrofit	Compressor Re-Wheel	Compressor Re-Wheel	/	/
3 - 1 x SCR	Disconnected	1533 SCR Retrofit	Compressor Re-Wheel	Compressor Re-Wheel	/	/
4 – 1 x DLE	Disconnected	1533 DLE Retrofit	Compressor Re-Wheel	Compressor Re-Wheel	/	/
5 - 1 x New Unit	Disconnected	Decom.	Compressor Re-Wheel	Compressor Re-Wheel	New Unit (Brownfield)	/
6 - 2 x New Units	Disconnected	Decom.	Compressor Re-Wheel	Compressor Re-Wheel	New Unit (Brownfield)	New Unit (Brownfield)
7 - 1 x New Unit + EUD	Disconnected	500Hr EUD	Compressor Re-Wheel	Compressor Re-Wheel	New Unit (Brownfield)	/
8 - 1 x Decom	Disconnected	Decom.	Compressor Re-Wheel	Compressor Re-Wheel	/	/

Table 2 - Options build up summary

Table 3 below provides a breakdown of the various costs that were included in the Cost Benefit Analysis.

Cost Comparison £m (2018-19 prices)	Non FES	FES Related Opex	
	Capital, Asset Health, Decommissioning + Site Operation (+/- 30%)	Compressor Fuel + Carbon Emissions	Constraint Management
1 – Counterfactual	38.16	5 - 137	2 - 32
2 - 1 x CSRP	42.37	5 - 135	2 - 32
3 - 1 x SCR	52.81	5 - 135	2 - 32
4 – 1 x DLE	45.03	5 - 135	2 - 39
5 - 1 x New Unit	87.20	5 - 134	1 - 17
6 - 2 x New Unit	153.09	5 - 134	0 - 2
7 - 1 x New Unit + EUD	109.16	5 - 135	0 - 4
8 - 1 x Decom	16.20	5 - 134	7 - 146

Table 3 - Options Cost Data

3.8. Non- Future Energy Scenario (FES) costs have a cost confidence interval of +/- 30% and vary between options. These costs include installation costs and ongoing Asset Health

and Site Operation costs. Cost estimates for the installation of new compressor units are based on external expert advice,⁹ while Asset Health costs are based on a site specific scoping exercise¹⁰ and unit costs from the RIIO-2 Final Determinations.

3.9. FES- related Opex costs are derived using a probability-based forecasting model. They vary between options and between Future Energy Scenarios 2021. The four Future Energy Scenarios, as described in the National Grid ESO FES,¹¹ provide different pathways to a net zero future. These range from Steady Progression, which falls just short of the net zero target, to Leading the Way, which achieves net zero ahead of 2050. Each scenario is dependent on assumptions about changes to government policy and legislation, energy delivery and consumption, consumer behaviour, technological change, and government incentives and investment. The Future Energy Scenarios provide a broad envelope of energy backgrounds against which the merits of alternative investments may be appraised.

3.10. The two lower natural gas usage scenarios (Consumer Transformation and Leading the Way) meet carbon reduction targets via electrification with changes in consumer behaviour and large improvements in energy efficiency. The use of hydrogen is considered in Leading the Way and System Transformation. Hydrogen is produced entirely using renewable electricity in Leading the Way, whereas in System Transformation gas continues to be used to produce blue hydrogen.

3.11. Compressor Fuel and Carbon Emission volumes are determined by forecast running hours (Table 8) and combined with forecast unit cost (Table 7) to derive four total cost estimates for each option, one for each Future Energy Scenario.

3.12. Constraint management costs, capacity buy backs and locational balancing arise because of the commercial actions the gas system operator takes to match the requirements of network users with the physical capabilities of the network. Constraint management costs are forecast using a network capability analysis model developed by National Gas Transmission to define the capability of the National Transmission System. Further details are

⁹ King's Lynn Compressor Emissions FOSR submission in January 2023 – Appendix C Engineering Report

¹⁰ King's Lynn Compressor Emissions FOSR submission in January 2023 – Appendix D Asset Health

¹¹ [Future Energy Scenarios 2022 | National Grid ESO](#)

given in the Gas Ten Year Statement (GTYS)¹² and Annual Network Capacity Assessment Report (ANCAR).¹³

3.13. A key factor in assessing network capability is compressor availability. Availability is a measure of how ready a given component in a system is to operate on demand. Typically measured over an extended period to smooth out the effects of day-to-day maintenance and faults, an overview of how this availability value is assessed and how it is used when assessing network capability is set out in the Compressor Emissions – Asset Management Plan.¹⁴

3.14. National Gas Transmission has commissioned the development of a Reliability Availability Maintainability (RAM) model¹⁵. This assessed availability across the entire compressor fleet and evaluated the impact of specific asset health interventions on compressor availability. In addition, a site-specific availability model was developed for Kings' Lynn.¹⁶ The results of the availability modelling undertaken for the site is one of the important inputs to the Cost Benefit Analysis model and can often drive the conclusions of the analysis.

3.15. Table 4 sets out the output from the Cost Benefit Analysis. The option with the highest Net Present Value (in this case the lowest negative) is the one that delivers compliance with the Directive at least cost over the assessment period. In the case of Steady Progression and System Transformation the lead option is Option 1 (Counterfactual), whereas in the case of Leading the Way and Consumer Transformation it is Option 8 (1 x Decom), which sees Unit B decommissioned with no replacement.

¹² [Gas Ten Year Statement \(GTYS\) | National Grid Gas](#)

¹³ [Network Capability | National Grid Gas](#)

¹⁴ King's Lynn Compressor Emissions FOSR submission in January 2023 – Compressor Emissions – Asset Management Plan

¹⁵ King's Lynn Compressor Emissions FOSR submission in January 2023- RAM Study

¹⁶ King's Lynn Compressor Emissions FOSR submission in January 2023- Appendix B – Site Availability Model

NPV £m (2018/19 prices)	Steady Progression	Consumer Transformation	Leading the Way	System Transformation
1 - Counterfactual	-£114 m	-£31 m	-£29 m	-£49 m
2 - 1 x CSRP	-£116 m	-£34 m	-£32 m	-£52 m
3 - 1 x SCR	-£124 m	-£42 m	-£40 m	-£60 m
4 - 1 x DLE	-£121 m	-£36 m	-£34 m	-£54 m
5 - 1 x New Unit	-£145 m	-£71 m	-£69 m	-£87 m
6 - 2 x New Unit	-£186 m	-£120 m	-£118 m	-£135 m
7 - 1 x New Unit + EUD	-£151 m	-£83 m	-£81 m	-£99 m
8 - 1 x Decom	-£160 m	-£23 m	-£19 m	-£49 m

Table 4 - Cost Benefit Analysis Outputs

3.16. To help quantify the whole life cycle environmental impact of each option, a Best Available Technology assessment¹⁷ was carried out. The assessment featured both quantitative and qualitative scoring of shortlisted options against key technical and environmental criteria, as well as whole life cycle emissions and costs. This assessment concluded that that all options would deliver very similar scores and would be considered Best Available Technology.

3.17. Several Security of Supply Case Studies were also considered. National Gas Transmission argue that Future Energy Scenarios are focused on forecasting domestic gas demand and how that demand is met. They do not provide a robust forecast of future imports or exports through the Bacton interconnectors, which are determined by market dynamics in Great Britain and Europe. Prolonged periods of either imports or exports at a level that requires parallel running of the compressors at King’s Lynn would risk breaching any 500-hour limit on Unit B, if operated under the Emergency Use Derogation. To evaluate the potential risk, the Cost Benefit Analysis was rerun assuming that the level of exports and gas prices observed in 2022 persisted over the entire assessment period. Table 5 below sets out the output from this sensitivity analysis.

¹⁷ King’s Lynn Compressor Emissions FOSR submission in January 2023 - Appendix G – Preliminary BAT Report Summary

NPV £m (2018/19 prices)	High Export Scenarios	
	BEIS Forecast 60p/th	Current Prices 150p/th
1 - Counterfactual	-£270 m	-£415 m
2 - 1 x CSRP	-£270 m	-£414 m
3 - 1 x SCR	-£278 m	-£423 m
4 - 1 x DLE	-£286 m	-£450 m
5 - 1 New Unit	-£277 m	-£380 m
6 - 2 New Units	-£296 m	-£358 m
7 - 1 New Unit + 1 x EUD	-£264 m	-£330 m
8 - 1 x Decommission Avon	-£478 m	-£931 m

Table 5 - Cost Benefit Analysis Outputs – High Export Scenarios

3.18. National Gas Transmission also considered the viability of each of the retrofit technologies included in Options 2, 3 and 4.

- Control System Restricted Performance (CSRP), not previously implemented on the National Transmission System or permitted by the Environment Agency- this option involves the application of an innovative control system modification.
- Selective Catalytic Reduction (SCR), not previously implemented on the National Transmission System or permitted by the Environment Agency - this option involves the use of hazardous substances (ammonia) and is complex to implement
- Dry Low Emissions (DLE), not previously implemented on the National Transmission System or permitted by the Environment Agency - this option involves application of a technology that has not yet been fully proven in commercial operation and is currently undergoing performance testing.

3.19. To determine the Final Preferred Option, the various assessments presented in the Final Option Selection Report were combined into a single assessment matrix as set out in Table 6 below.

Option	Emissions Compliance	BAT Assessment	CBA	Security of Supply / Case Study	Technology Risk	Capital Investment
1 – Counterfactual	Achieves MCPD Compliance through Derogation Note: No NOx emissions abatement.	Lead Configuration: BAT Back-Up Score: 51% Versatility: 9/15%	Modelling based on FES does not capture key use cases of the site and risks resulting from loss of capability	Ruled Out Unrestricted backup necessary in event of parallel running		
2 - 1 x CSR	Achieves MCPD Compliance through Abatement Note: No NOx emissions abatement.	Lead Configuration: BAT Back-Up Score: 57% Versatility: 9/15%		Provides Unrestricted Running	Ruled Out Avon exceeds original design life which risks critical site operation. Additional risk of CSR permit rejection from EA	
3 - 1 x SCR	Achieves MCPD Compliance through Abatement	Lead Configuration: BAT Back-Up Score: 57% Versatility: 9/15%		Provides Unrestricted Running	Ruled Out Avon exceeds original design life which risks critical site operation. Requires new HSE procedures to handle ammonia on site and introduces new failure mode onto NTS.	
4 – 1 x DLE	Achieves MCPD Compliance through Abatement	Lead Configuration: BAT Back-Up Score: 66% Versatility: 9/15%		Provides Unrestricted Running	Ruled Out Avon exceeds original design life which risks critical site operation. Additional risk that solution not yet commercially proven.	
5 - 1 x New Unit	Achieves MCPD Compliance through New Unit Build	Lead Configuration: BAT Back-Up Score: 89% Versatility: 15/15%		Provides Unrestricted Running	New Compressor Technology proven on NTS	
6 - 2 x New Unit	Achieves MCPD Compliance through New Unit Build	Not Assessed (4 Unit Site)		Provides Unrestricted Running	New Compressor Technology proven on NTS	Ruled Out
7 - 1 x New Unit + EUD	Achieves MCPD Compliance through New Unit Build / Derogation	Not Assessed (4 Unit Site)		Provides Unrestricted Running Note: Avon exceeds original design life but any risks are balanced out by new unit	New Compressor Technology proven on NTS	Ruled Out
8 - 1 x Decom	Achieves MCPD Compliance through Decommission	Not Assessed (2 Unit Site)		Ruled Out back-up required for parallel running		

Table 6 – King’s Lynn Assessment Matrix

Final Preferred Option

3.20. The Final Option Selection Report identified Option 5 as the Final Preferred Option for approval by the Authority in compliance with Special Condition 3.11.8

3.21. The Final Preferred Option involves the installation of a new compressor unit which will be commissioned by 2028. The required compressor driver type (electric or gas) and power rating will be confirmed during Front End Engineering Design. Cost estimates and capability assessment are based on a gas driven unit of 15 MW capacity. This unit would become the lead unit on site. The new unit will be installed on a brownfield site location. The existing SGT400 units (Unit C and D) to be re-wheeled to improve compression mapping. The option also includes decommissioning of the existing Avon units (Unit A and B) down to plinth level once the new compressor has been commissioned. The requirement for Unit B decommissioning will be reassessed following operational acceptance of the new unit.

4. Our assessment and proposed Final Preferred Option

Section summary

In this chapter we offer for consideration our assessment of the evidence set out in the Final Option Selection Report and the reasons for our proposed Final Preferred Option

Questions

Question 4.1: Do respondents agree with our assessment of the evidence presented in the Final Option Selection Report?

Our assessment of the 'needs case'

4.1. In our RIIO-T2 Final Determinations, we accepted the 'needs case' for investment at the King's Lynn Compressor Station to ensure compliance with the Directive. The Final Option Selection Report aligns with National Gas Transmission's Compressor Emissions Asset Management Plan (CE-AMP), which has been updated since Final Determinations and continues to demonstrate the need for compliance-related investment at King's Lynn Compressor Station.

Our assessment of options considered and shortlisted

4.2. Our assessment is that the Final Option Selection Report considered an appropriate range of available options and shortlisted only those options which would provide a viable solution, given the operational requirements at King's Lynn Compressor Station. Information on the option evaluation methodology was clearly articulated and applied in a consistent and logical manner.¹⁸ The shortlisted options included the counterfactual 'do nothing' option,

¹⁸ Kings Lynn Compressor Emissions FOSR submission in January 2023 - Appendix C – Engineering Report and Appendices

against which all other shortlisted options were assessed. While the shortlist of options assessed in the Cost Benefit Analysis does not include a market-based solution, constraint management payments, which are the commercial alternative to providing compressor services at King's Lynn, are central to the assessment of each option in the Cost Benefit Analysis.

4.3. We note that the detailed description of Option 5 in the Final Option Selection Report states that drive type (electric or gas) for the new compressor unit will be confirmed during Front End Engineering Design. There is a material difference in cost and schedule between installing an electric drive and a gas turbine and we believe that such a decision should be made at the current stage of the project rather than being delayed until the FEED stage. The evidence presented in the Final Option Selection Report was based on a gas turbine and we have made our judgement on this basis. The results of the option selection process do not warrant revisiting this item on this occasion but we discourage this approach in future submissions.

Our assessment of key Cost Benefit Analysis parameters

Base Assumptions

4.4. Our assessment is that all the key parameters used in the construction of the Cost Benefit Analysis and set out in Table 7 below are appropriate with a sound rationale. They were taken from the existing regulatory framework or published Government guidance. National Gas Transmission has clarified that, with respect to Constraint Management Method, entry capacity constraints are negligible at King's Lynn, with almost all constraints being at exit. Locational balancing actions are the only commercial constraint management tool available at exit.

Category	Assumption	Base Assumption	Rationale
CBA parameters	WACC	2.81%	Defined in RIIO-T2
	Social Time Preference Rate	3.5% (Years 0 – 30) / 3.0 % (30+)	Defined in Green Book
	Regulated Asset Life	45 years	Defined in RIIO-T2
	Assessment Period	25 years	Based on lifetime of asset
	Depreciation	SOTYD	Defined in RIIO-T2
	Capitalisation	75.00%	Defined in RIIO-T2
Constraints and Fuel	Gas Price	Annual price 50 – 64 p/th	BEIS reference scenario
	Compressor Fuel Costs	Gas Price	
	Constraint management pricing	Locational Sells: 0 Locational Buys: 1.2 * Price Buy Backs: Gas Price	As defined by Commercial Constraint Price Methodology
	Constraint management method	Enty Capacity 50% buybacks/50% locational actions Exit Capacity 100% locational actions	Reflective of tools available to manage constraints
Emissions	CO2 cost	Annual price 241 – 378 £/tonne	BEIS Valuation of greenhouse gas emissions: for policy appraisal and evaluation: Central Case
	NOx price	£6,199 £/tonne	DEFRA damage costs

Table 7 - Cost Benefit Analysis Assumptions

Capital Expenditure & Asset Health Cost Estimates

4.5. Our assessment is that the Capex, Asset Health (including Retrofit & Re-wheel), Decommissioning and Ongoing Site Operation cost estimates, included in the Cost Benefit Analysis, have been arrived at using appropriate data sources and assumptions. The level of

cost confidence to which these estimates have been made is appropriate for a project at this stage of development and is in line with guidance published by the Infrastructure and Project Authority.¹⁹ This level of cost confidence is appropriate for an option selection process including Cost Benefit Analysis and Best Available Technology assessments.

4.6. In making this assessment, we sought further information on assumptions related to the build-up of Asset Health costs. National Gas Transmission have indicated that they believe that the Asset Health costs provided are in line with the required cost estimate accuracy of +/-30%. They have been generated following visual inspections of the assets. There may be a need for more intrusive inspections during the detailed design phase of the project, but National Gas Transmission have not highlighted any significant issues that put the decision-making process at risk at this time. Given that the assets are operating under a normal integrity inspection regime following standard protocols, we believe this is an acceptable approach to take.

Constraint Management, Compressor Fuel & Carbon Emission Cost Estimates

4.7. Our assessment is that constraint management, compressor fuel and carbon emission cost estimates have been derived using the established probabilistic network capability forecasting methodology that underpins both the Gas Ten Year Statement (GTYS) and Annual Network Capacity Assessment Report (ANCAR). It is outside the scope of this consultation to review this methodology.

4.8. The model generates predicted flows of gas through King's Lynn Compressor Station, on an hourly basis, using a complex supply and demand model. A set of simple logical rules are then used to determine the total number of hours during which the King's Lynn Compressor Station is operating under a single unit or parallel running mode of operation. Under Option 1 (Counterfactual) the non-compliant Avon (Unit B) will only be used in situations where there are insufficient compliant SGT400s (Units C and D) available due to either planned or unplanned outages. Unit B is therefore most likely to be utilised during periods of parallel running. In making our assessment we sought further information on the predicted running hours set out in Table 8 below.

¹⁹ [IPA Cost Estimating Guidance.pdf \(publishing.service.gov.uk\)](https://www.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/428222/ipa_cost_estimating_guidance.pdf)

4.9.

Future Energy Scenario	Site Operation	2030	2035	2040	2045	2050
Steady Progressuin	Single Running	1311	1993	2195	2193	167
	Parallel Running	29	161	202	193	11
Consumer Transformation	Single Running	322	148	53	14	0
	Parallel Running	10	6	1	0	0
Leading the Way	Single Running	204	122	18	0	0
	Parallel Running	6	3	0	0	0
System Transformation	Single Running	511	616	504	578	91
	Parallel Running	13	29	26	33	7
High Export Scenarios	Single Running	3163	4911	5228	5156	432
	Parallel Running	41	435	653	606	22

Table 8 – Forecast Running Hours

4.10. These data indicate that the non-compliant Avon (Unit B) will only rarely be utilised and would be very unlikely to breach the 500-hour Emergency Use Derogation limit. This is supported by the very low Constraint Management costs reported in Table 3 above.

Compressor Availability

4.11. Our assessment is that the approach taken to modelling site availability is appropriate and the models have been through a Quality Assurance procedure and have been approved by competent professionals. Table 9 below sets out the availability assumptions, following proposed interventions²⁰ used in the construction of the Cost Benefit Analysis.

²⁰ Both Asset Health and Control Systems, the cost of the former is included in the CBA however the latter is excluded as it is associated with an unrelated system wide upgrade.

Train Type	Availability
Avon 500 Hour EUD	79.50%
Avon CSR	79.50%
Avon SCR	79.50%
Avon DLE	74.50%
SGT-400	80.00%
New Unit	90.00%

Table 9 – Compressor Availability Assumptions

4.12. A penalty of 5% has been applied to interventions that include a Dry Low Emissions technology retrofit to account for the immaturity of the technology. A reduction to the availability of the unproven technology is fair in the analysis but we believe it would be excessive to apply this penalty for the duration of the assessment period as experience should see it dissipate over time.

4.13. The “New Unit” availability figure is based on observed performance of new gas turbine compressors installed at other compressor stations such as Felindre. We believe the availability value used for the new unit is appropriate for this analysis.

Future Energy Scenarios

4.14. Our assessment is that the appropriate Future Energy Scenarios have been used in the Cost Benefit Analysis. National Gas Transmission argue that Future Energy Scenarios do not provide a robust forecast of future imports or exports through the Bacton interconnectors which are driven by market dynamics. We recognise that as trade across the Bacton Interconnectors is driven by market conditions in adjacent markets predicting the direction and volume of trade in any future period involves a great deal of certainty. However over a longer forecast period market fundamentals will assert themselves and the volatility that can be observed between periods will be smoothed out. Future Energy Scenarios do not attempt to predict future imports or exports but provide a range of outcomes based on plausible variations in market fundamentals. We continue to believe that the pattern of trade observed in 2022 is atypical and should not be given significant weight when considering future trade patterns at this time.

Our Assessment of Best Available Technology

4.15. Our assessment is that the Best Availability Technology methodology used by National Gas Transmission is appropriate for this stage of the project. The key finding from the assessment is that all shortlisted options represent Best Available Technology. This finding is driven by the relatively low run hours required for any back-up unit (Table 8).

Our Assessment of Project Risk Register²¹ and Project Programme²²

4.16. Our assessment is that an appropriate Risk Register has been established and maintained. The majority of risks are routine for a project of this type, with acceptable mitigations proposed. We have however identified two unique and high impact risks:

- Control System Restricted Performance (CSRP) may not be considered by the Environment Agency as complying with Best Available Technology requirements, resulting in the necessary environmental permits being withheld.
- Avon Dry Low Emissions (DLE) Retrofit technology effectiveness, cost and availability remains uncertain ahead of the final stages of testing being completed.

4.17. Our assessment is that an appropriate project programme has been developed for each of the shortlisted options. The differences in scope, types of construction/operating risk, in particular periods of plant outage between new build and retrofit options, have been recognised in the project programme.

Discussion

²¹ King's Lynn Compressor Emissions FOSR submission in January 2023 - Appendix F – Project Risk Register

²² King's Lynn Compressor Emissions FOSR submission in January 2023 - Appendix E – Project Programmes

4.18. We note the assessment matrix (Table 6) provided by National Gas Transmission. We believe it provides a clear articulation of the various considerations that contribute to the overall decision-making process. We agree that, although Cost Benefit Analysis and Best Available Technology assessments are key decision making tools, they are not the only considerations that should be given weight, nor should they be used in isolation. The assessment matrix presented by National Gas Transmission suggests an approach that excludes certain options before all the relevant considerations have been assessed. We believe that a better approach is to subject all options to the full assessment which permits a fully informed decision.

4.19. We broadly agree with the assessments set out in this matrix with respect to:

- Emissions Compliance
- Best Available Technology
- Technology Risk
- Capital Investment

4.20. . However, we disagree on two key points.

4.21. We do not accept that the use of Future Energy Scenarios as a basis for the Cost Benefit Analysis renders that analysis an inappropriate decision-making tool for investments at King's Lynn Compressor Station. Future Energy Scenarios do not attempt to predict future imports or exports but provide a range of outcomes based on plausible variations in market fundamentals. They therefore provide a more appropriate basis for long term investment decisions than would a single forecast. Permanent shifts in market fundamentals may lead to Future Energy Scenarios including much higher exports through the Bacton Interconnectors. In these circumstances the question of whether it is cost effective to install a new gas turbine at King's Lynn Compressor Station may need to be re-visited during a subsequent price control period..

4.22. We do not accept that the Security of Supply Case Studies justify the exclusion of the counterfactual (Option 1) from being identified as the Final Preferred Option. The high export scenarios referred to assume that the export volumes and gas prices observed over the previous twelve months since the invasion of Ukraine persist for the entire assessment period out to 2050. We consider this to be an extreme scenario with very little justification to support it. Conversely the high import scenario referred to is the 'Beast from the East' weather event from 2018 which only lasted a few days. As noted in the Final Option Selection Report, King's Lynn Compressor Station is not directly linked to any domestic demand

obligations. However we accept that any potential restriction on imports during a period of high demand would have a negative impact on the wholesale gas market.

4.23. We accept the exclusion of Option 8 (decommissioning of Unit B without replacement). Given the uncertainty that exists with respect to the future development of the gas industry and the critical role of King's Lynn Compressor Station in supporting imports and exports through the Bacton Terminal, it would not be appropriate to follow a course of action that permanently removed the opportunity to pursue a number of potentially viable options at a future date.

4.24. This leaves two viable options, Option 1, where the existing Avon (Unit B) is retained under the 500 hour Emergency Use Derogation, and Option 5, where a new compressor unit is installed. The Cost Benefit Analysis (Table 4) puts Option 1 ahead of Option 5 under all Future Energy Scenarios. We note that the Cost Benefit Analysis that accompanied the Security of Supply Case Studies (Table 5) did not demonstrate a clear advantage for Option 5 over Option 1.

4.25. We note the risks identified by National Gas Transmission with respect to the age of Unit B which will have been installed for over 60 years by 2030. In assessing such risks, unit condition is a more relevant metric than age, condition being a function of past run hours and asset health intervention. We expect that the condition of Unit B will have been reflected in the Best Available Technology assessment, Site Availability Model and level of Asset Health expenditure included in the Cost Benefit Analysis. None of these indicated a particular issue with the current condition of this unit. Investing in the network based on condition and not simply age is an important principal when operating an economic and efficient system.

4.26. We note that Unit B is described in the Final Option Selection Report as being the lead unit during the recent period of very high exports. Any risk that may exist would in addition appear manageable under Option 1 as Unit B will act as back up to the two primary SGT400s (Units C and D). Table 10 below sets out historical run hours at Bacton Compressor Station.

Individual Unit Running Hours (financial years)				
Gas Year	Unit B	Unit C	Unit D	Total
2016/17	12	22	139	173
2017/18	747	10	1,131	1,887
2018/19	21	72	26	118
2019/20	1	40	30	71
2020/21	178	778	628	1,584
2021/22	126	109	199	434
Apr – Dec 2022	2,891	2,794	1,396	7,081

Table 10 - Historical Unit Runtimes

4.27. Regarding issues relating to long-term operation of an Avon, we believe that the Avon market is sufficient large that suitable support will continue to be available into the future. Should the risks identified crystallise at some point in the future, then there will be sufficient time to take mitigating action.

4.28. Based on this assessment we propose that the counterfactual (Option 1), where the existing Avon (Unit B) is retained under the 500 hour Emergency Use Derogation, should be the Final Preferred Option.

Avon Retrofit Technologies

4.29. With respect to those options (Options 2 to 4) that involve the retrofitting of the existing Avon (Unit B), we agree with National Gas Transmission’s assessment that it would not be appropriate to determine a Final Preferred Option that may turn out to be undeliverable. There is an unknown level of risk that the various retrofit options, may not receive Environment Agency approval, or may not be viable in practice. Clarity on these risks will develop over coming years.

4.30. The scope of asset health intervention needed to prepare an existing Avon for continued operation under the 500-hour Emergency Use Derogation is the same as that required prior to any retrofit with either Control System Restricted Performance or Dry Low Emissions technology. Proceeding with Option 1 does not therefore create an obstacle to future adoption of Options 2 or 4. While the Final Option Selection Report assumed an

availability penalty for Dry Low Emissions technology, we believe that any such penalty would dissipate over time as operators and manufacturers gain experience.

4.31. The Final Option Selection Report indicates that the additional cost of retrofitting over and above the asset health works associated with the Emergency Use Derogation would be under £5m. We believe this additional expenditure could be justified as it would remove the limit on running hours and provide extra resilience at the King's Lynn Compressor Station. While performance will not match that of a new unit, it will be sufficient materially to boost network resilience at a much lower initial cost.

4.32. Should National Gas Transmission identify a cost effective retrofit that will permit unrestricted operation of the retained Avon (Unit B), then we would expect National Gas Transmission to implement that solution and seek funding as part of the next price control

5. Proposed Final Preferred Option

Section summary

In this chapter we set our proposed Final Preferred Option

Questions

Question 5.1: Do respondents agree with our proposed Final Preferred Option?

Question 5.2: Do respondents agree with our proposals approach to potentially removing restrictions on the operation of the retained Avon (Unit B)?

Our Proposal

5.1. Based on our assessment of the evidence included in the Final Option Selection Report, in accordance with Special Condition 3.11.9, we propose to reject the option identified by National Gas Transmission as the Final Preferred Option (Option 5) and approve one of the other shortlisted options (Option 1) as the Final Preferred Option.

5.2. We propose as the Final Preferred Option retention of the existing Avon (Unit B) under the 500-hour Emergency Use Derogation allowed for in the Directive, with significant asset health investment to improve unit availability. To ensure operation- mapping alignment across all site compressors, this option will also consider the case for a re-wheel of the existing SGT-400s during the next phase of the project.

5.3. Separately, should National Gas Transmission identify a cost effective retrofit, that will permit unrestricted operation of the retained Avon (Unit B). Then we would expect National Gas Transmission to implement that solution and seek funding as part of the next price control

Appendix 1 – Privacy notice on consultations

Personal data

The following explains your rights and gives you the information you are entitled to under the General Data Protection Regulation (GDPR).

Note that this section only refers to your personal data (your name address and anything that could be used to identify you personally) not the content of your response to the consultation.

1. The identity of the controller and contact details of our Data Protection Officer

The Gas and Electricity Markets Authority is the controller, (for ease of reference, "Ofgem"). The Data Protection Officer can be contacted at dpo@ofgem.gov.uk

2. Why we are collecting your personal data

Your personal data is being collected as an essential part of the consultation process, so that we can contact you regarding your response and for statistical purposes. We may also use it to contact you about related matters.

3. Our legal basis for processing your personal data

As a public authority, the GDPR makes provision for Ofgem to process personal data as necessary for the effective performance of a task carried out in the public interest. i.e., a consultation.

3. With whom we will be sharing your personal data

(Include here all organisations outside Ofgem who will be given all or some of the data. There is no need to include organisations that will only receive anonymised data. If different organisations see different set of data, then make this clear. Be as specific as possible.)

4. For how long we will keep your personal data, or criteria used to determine the retention period.

Your personal data will be held for ***(be as clear as possible but allow room for changes to programmes or policy. It is acceptable to give a relative time e.g., 'six months after the project is closed')***

5. Your rights

The data we are collecting is your personal data, and you have considerable say over what happens to it. You have the right to:

- know how we use your personal data
- access your personal data
- have personal data corrected if it is inaccurate or incomplete
- ask us to delete personal data when we no longer need it
- ask us to restrict how we process your data
- get your data from us and re-use it across other services
- object to certain ways we use your data
- be safeguarded against risks where decisions based on your data are taken entirely automatically
- tell us if we can share your information with 3rd parties
- tell us your preferred frequency, content, and format of our communications with you
- to lodge a complaint with the independent Information Commissioner (ICO) if you think we are not handling your data fairly or in accordance with the law. You can contact the ICO at <https://ico.org.uk/>, or telephone 0303 123 1113.

6. Your personal data will not be sent overseas (Note that this cannot be claimed if using Survey Monkey for the consultation as their servers are in the US. In that case use “the Data you provide directly will be stored by Survey Monkey on their servers in the United States. We have taken all necessary precautions to ensure that your rights in term of data protection will not be compromised by this.”

7. Your personal data will not be used for any automated decision making.

8. Your personal data will be stored in a secure government IT system. (If using a third-party system such as Survey Monkey to gather the data, you will need to state clearly at which point the data will be moved from there to our internal systems.)

9. More information For more information on how Ofgem processes your data, click on the link to our “[Ofgem privacy promise](#)”.