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National Grid Gas Transmission (NGGT) response to Wormington Compressor Emissions – Final Preferred Option

Dear Graham,

This letter is NGGT's response to the Ofgem consultation on Wormington Compressor Emissions – Final Preferred Option, dated 5 December 2022. NGGT own and operate the gas transmission assets in Great Britain (GB), which are defined as Critical National Infrastructure by the UK Government. We meet the needs of our customers and GB consumers, enabling gas to be transported around GB safely and efficiently. We operate our network to meet both our customers' demands and entry and exit obligations.

We do not support Ofgem's minded-to position regarding the option for Wormington compressor station and we have set out our reasons in this response and provided evidence in the associated appendices. To summarise, our key concerns with Ofgem's preferred option are:

1. The underlying planning assumptions (Future Energy Scenarios (FES)) do not represent current developments in the gas supply market and therefore ignore credible high Liquefied Natural Gas (LNG) scenarios.
2. The resilience impact (and therefore potential supply loss) at Wormington has been understated and could have significant financial and operational impacts.

We believe that our option selection process has provided the evidence to support our final preferred option, which has the highest Net Present Value (NPV) under two out of four FES scenarios¹. However, this response provides additional quantitative and qualitative evidence to supplement our previous submission, which we believe further strengthens the needs and the value case for the investment of two new gas-driven compressors at Wormington compressor station.

1. Future of gas scenario planning assumptions

The capability provided by Wormington compressor station is fundamental to GB's ability to maximise LNG imports via the Milford Haven terminals as part of the GB Security of Supply plans. The station also provides resilience in supply of gas to South Wales and the South West in order to meet the 1-in-20 peak demand obligation² to consumers and wider resilience to Europe through interconnectors.

The importance in our ability to bring LNG into GB has never been more critical with the decrease in gas supplies from Europe. Milford Haven has supplied 30 percent³ of GB's gas demand, highlighting its importance as a supply point into the network. Since our RIIO-2 business plan submission in 2019, and the global events in 2022, the supply of gas to the UK has changed and the Security of Gas Supply risk has increased significantly. Even before the events

¹ For two out of four FES scenarios NGGT's preferred options ranks 1st following the CBA analysis provided as part of the submission in August 2022.

² National Grid (2021), Transmission Planning Code, Standard Special Condition A9: Pipe-Line System Security Standards

³ Instantaneous supply 14:00 28/01/2022

of 2022, the increased value of LNG was demonstrated by the customer triggered investment to increase the baseline capacity to 103 mcm/day⁴. The FES⁵ scenarios do not reflect the current reality of highly flexible energy supplies by LNG and do not cater for credible scenarios regarding LNG supply in the future. Over the last year we have seen actual LNG imports well above any FES scenario at ~25 bcm/year (with the highest FES scenario being at 11 bcm/year⁶). To underline the value to GB, there is up to 650 mcm of gas stored in the LNG tanks at Milford Haven.

In addition to the recent experience of LNG supply, industry forecasts now show significant annual volumes of future LNG supply expected to come to GB. Importantly these volumes are much higher than the FES volumes. Forecasts show 20 to 25 bcm/year of LNG imports out to 2040, which is circa double the levels assumed in any of the FES scenarios, see appendix 2 for currently predicted LNG imports compared to underlying assumptions in FES 2021.

We recognise the FES scenarios represent an envelope of potential long-term views of the energy landscape but in this case do not solely cater for the more recent likely long-lasting impacts of global events described above. FES assumes supply forecasts are based on meeting GB demand only and do not account for market imbalances, which we have seen in 2022, where LNG is arriving to meet regional deficits caused by the drop of Russian gas supplies with GB being an important gateway to bring LNG into Europe via interconnectors. Additionally, FES states gas demand will reduce as we near 2050 in all four scenarios. NGGT strongly believe the rate in the decline of gas demand will not be as prominent as stated, with demand staying above the higher electrification scenarios (Leading the Way and Customer Transformation).

This context is vitally important as our quantitative options selection analysis uses FES as a key input and as described above, we have significant reservations in the underlying flow assumptions stated in FES 2021⁷ (see more detail in appendix 1 regarding our discussion on FES). Even on an equally weighted basis of the FES scenarios, we believe we provided strong evidence to support our final preferred option regardless of the additional newly provided signals to reflect higher LNG supplies.

2. Financial and operational impacts resulting from understated resilience

Ofgem's proposal⁸ requires NGGT to limit the annual usage of one gas compressor to 500-hour Emergency Use Derogation (EUD)⁹, due to the emission legislation from 2030, which puts NGGT's ability to deliver energy security for customers at risk and reduces the resilience and flexibility of our network. It is our view that Ofgem's minded-to position is underplaying the role of resilience at Wormington.

The site consists of one electrically-driven Variable Speed Drive (VSD) compressor (primary unit) and two non-MCPD (Medium Combustion Plant Directive) compliant gas-driven compressors. A gas-driven compressor is operated in parallel with the VSD compressor during high entry flows. In addition to our quantitative analysis, which looks at probabilities of events and average impacts over 25 years, we supplemented our analysis with qualitative information. This includes impacts when the VSD is unavailable for a period of time, due to planned or unplanned outages. When the VSD is unavailable, one or both gas-driven compressors would be required to operate.

Restricting a compressor under 500-hour EUD, would reserve its operation for commercial entry constraint management only. Reserving these limited hours to provide security would remove it from standard operation, giving

⁴ This represents a 17% increase on the existing obligated baseline at the Milford Haven entry point. South Hook LNG have issued a request for this increase in entry capacity through the Planning and Advanced Reservation of Capacity Agreement (PARCA).

⁵ For the Wormington Compressor Station Final Options Selection Report (FOSR) submission to Ofgem in August 2022, we have used the FES 2021 data, as this was the most recently available FES. FES 2021 data will be used for our other submissions to maintain consistency. [Future Energy Scenarios 2022 | National Grid ESO](#)

⁶ LNG supply (predominantly from Milford Haven) in 2022/23 (year to date) has been in excess of the Steady Progression scenario. Steady progression scenario has the highest gas flows and both overall supply and import dependency are high until 2050.

⁷ We have described our analysis on 2021 FES as part of our August 2022 submission in Compressor Emissions-Asset Management Plan (CE-AMP), chapter 3.

⁸ NGGT's final preferred option for Wormington Compressor Station is to install two new gas-driven compressors by 2030 in line with the Medium Combustion Plant Directive (MCPD) emissions legislation deadline, to replace the two non-compliant gas-driven compressors (Option 10 in the FOSR submitted to Ofgem in August 2022). Ofgem's minded-to position is to approve the installation of only one new unit, with the remaining gas-driven turbine to be maintained under 500-hour EUD (Options 7).

⁹ See appendix 3 on further detail on 500-hour EUD restrictions.

insufficient resilience for the other compressors on site. Further consideration needs to be given to the limited operation of the compressor, which can negatively impact its availability due to faults not becoming present until utilisation, when its availability and operation is vital. Failure to be available when required would lead to constraints and prevent flow of LNG to the GB. See further detail in appendix 5 on the VSD resilience assumptions.

Whilst our option selection process provides good evidence for our final preferred option, it is also our view that some key factors underestimate the future role and importance of LNG. For example, the existing Cost Benefit Analysis (CBA) process does not factor in entry constraints impacts on wholesale gas prices.

There are credible single failure events which consequently would have significant financial and operational impacts. To demonstrate those impacts we have analysed wholesale gas prices¹⁰ using a scenario with a shortfall of 10-15 mcm/day¹¹ on LNG import leading to a wholesale gas price impact of around £76m¹² over 5 days, see appendix 6 for further detail. This means a reduction in supply would result in increased gas prices, impacting GB's economy and consumer bills. Ofgem's proposal would limit the length of time we could meet the needs of the network to 21 days¹³ should the electric drive fail. In this situation we would need to curtail the supply of LNG into the UK to prevent pressure breaches, which could be for a number of months in the worst case VSD failure scenarios.

In light of the evidence provided within our FOSR submission as well as the key concerns detailed in this response and new analysis regarding LNG forecast and wholesale gas price impacts, we believe investing the additional ca. £40m¹⁴ to insure against a potential £76m (over 5 days) best case impact scenario, is in our view the right way to secure GB's Security of Supply beyond 2030. Ofgem's minded-to position is placing significant and unnecessary risks on customers and consumers.

Our principle is that to achieve emissions compliance we should ensure that this does not degrade our network capability or resilience to meet the current and future needs of our customers and consumers. As the above impacts show, developing our network using low gas usage scenarios as the design basis risks limiting the GB's ability to maximise supply options for gas in the short to mid-term. On this basis, we strongly advise that we should invest in two new emissions compliant gas-driven compressors which are not restricted in operation by emissions legislation. This will ensure that GB's gas transmission network is able to accommodate a wide range of gas demand and supply scenarios, and ensure we maintain appropriate resilience whilst meeting emissions legislation compliance.

Within appendix 1 to this response, we provide the answers to the specific question posed by Ofgem.

Further Engagement and Next Steps

As this is the first FOSR submission under the RIIO-T2 Special Condition 3.11 Compressor emissions Re-opener and Price Control Deliverable, we appreciate the continued engagement with Ofgem regarding this project. A timely final decision on the final preferred option will enable us to ensure we successfully deliver the emissions compliance and resilience required at Wormington.

If you have any queries, please do not hesitate to contact myself or Barbara Grabe-Yates, Regulatory Development Manager ([REDACTED]).

Yours sincerely

Tony Nixon – By Email

Regulation Director, Commercial - On behalf of NGGT

¹⁰ Figures from [REDACTED] analysis on NBP monthly price impact from 20 mcm/per day supply loss from Milford Haven over 5 days based on their 2023 GB gas market balanced, see Appendix 6 for further details.

¹¹ The shortfall is post WGN driven investments.

¹² Pro-rated from £101m with a shortfall of 20 mcm on a summer day as detailed in appendix 6.

¹³ 21 days is calculated assuming 500 hours of running over a rolling three-year average. The legislation allows a maximum of 750 hours running per year as long as a 500 hour average across a rolling three years is not exceeded. We believe 500 hours is the correct planning assumption and a 750 hours maximum would need to be managed by short-term operational concerns.

¹⁴ £40m total installed cost compared to Ofgem's preferred option

Appendix 1 – Consultation Question Responses

Question 4.1: Do respondents agree with our assessment that, assuming a 50:50 split between constraint management tools, capacity buy back and locational action, is not supported by the available evidence? What do respondents believe would be a more appropriate assumption?

It is our view that the overall supply of gas should not be to mitigate the consequences of a constraint once it has occurred but providing solutions that minimise constraints occurring in the first place. We believe the calculation of constraints represents a fair representation of the risk associated with potential future gas supply pattern. A 50:50 split between constraint tools is appropriate when averaged across a year, however, likelihood is that 100% buy backs would be more appropriate in a high demand/low supply margins scenario given the uncertainties in forecasted gas flows.

NGGT recognise that historical constraints at Milford Haven have been resolved by locational actions. However, these constraints were during periods of lower demand where locational actions, reliant on there being line pack available to sell can be utilised. In periods of higher demand, it is expected that capacity buy backs are more likely to occur due to severity of, and increased frequency of constraints impacting LNG deliveries at the terminals and therefore the 50:50 assumption is conservative

If insufficient investment is made on our assets to provide the required capability and resilience, the likelihood of greater constraints over a sustained duration is increased. The future role of LNG in the GB energy mix, supporting the move away from Europe's dependence on Russian gas and the transition to NetZero, further increases the volume of LNG entering the network at Milford Haven (as described in our response above).

Question 4.2: Do respondents agree with our assessment that the VSD available is the correct BAT assessment to use when comparing the shortlisted options?

The preliminary Best Available Technique (BAT) assessment for VSD available and unavailable scenarios has been considered as part of the option selection process and is included in appendix G of our submission. As Ofgem note in their draft response, BAT assessment and CBA are key tools for decision making and should not be used in isolation. We do not agree that the VSD available scenario should be used as the primary scenario in decision making for back-up compression. Both VSD available and unavailable scenarios should be considered in the BAT assessment alongside other decision tools and criteria as presented in the FOSR.

Question 4.3: Do respondents agree with our assessment of the evidence presented in the Final Option Selection Report?

NGGT agree with some of Ofgem's assessment of the FOSR for Wormington. The areas of disagreement are listed below and are covered indirectly throughout the rest of this document.

BAT VSD Availability

Our response to this is covered in Question 4.2

Base Case Scenario

System Transformation was selected as the base case scenario¹⁶, however Ofgem do not believe this is appropriate. Ofgem state FES scenarios are a series of potential pathways to a net zero future, where no individual scenario is any more probable than another. Our assessment of the FES scenarios has seen flows trending to those stated in System Transformation and not the higher electrification ones. We predict demand to remain this way until policy decisions have been made and incentives are in place to encourage a reduction in gas use. System Transformation was selected in Ofgem's RIIO-ED2 draft determination "because this relatively conservative Future Energy Scenario will ensure that consumers do not speculatively fund work that may not be required"¹⁷.

We have described our concerns around the underlying assumptions regarding the FES 2021, which has been used to support our options selection process, as part of our FOSR submission¹⁸. The immediate decrease in annual gas demand (forecast by two of the four FES scenarios) is unrealistic considering current consumer behaviour and lack of existing incentives. The continued delay to GB electrification will further strengthen justification for the two new unit investment. We have assessed all available FES scenarios as part of this process, but we have significant reservations of the underlying flows (as described in our response above). We have completed some further analysis regarding the demand reductions following the 5-year forecast, which is showing FES demand reductions have been above all three NetZero scenarios. The installation of heat pumps to date and the underlying assumptions in FES are an indication of the delay of electrification. See Figure 1 below which shows a comparison between actual installations vs. UK Government targets and FES 2021.

As already stated above FES is limited as supply forecasts are based on meeting GB demand only and do not account for market imbalances, which we have seen in 2022, where LNG is arriving to meet regional deficits caused by the drop of Russian gas supplies with GB being an important gateway to bring LNG into Europe via interconnectors.

Given the fundamental changes to the gas market in 2022, which we have described above, we need to invest in the assurance of having the appropriate site availability and resilience in Wormington to support the supply of gas now and beyond 2030. In addition to our views on the FES scenarios, there is the matter of risk management to consider. It is imperative that we plan the network to sufficient resilience levels to manage credible possible outcomes. To that end we believe there is significant evidence to support our preferred option.

¹⁶ In the August 2022 FOSR we have used the System Transformation scenario as the base case for this report as it provides an appropriate central case for Wormington's expected range of operation. Sensitivities to the analysis against the other three scenarios have also been included.

¹⁷ RIIO-ED2 Draft Determinations – Overview Document <https://www.ofgem.gov.uk/publications/riio-ed2-draft-determinations>

¹⁸ We have described our analysis on 2021 FES as part of our August 2022 submission in CE-AMP, chapter 3.

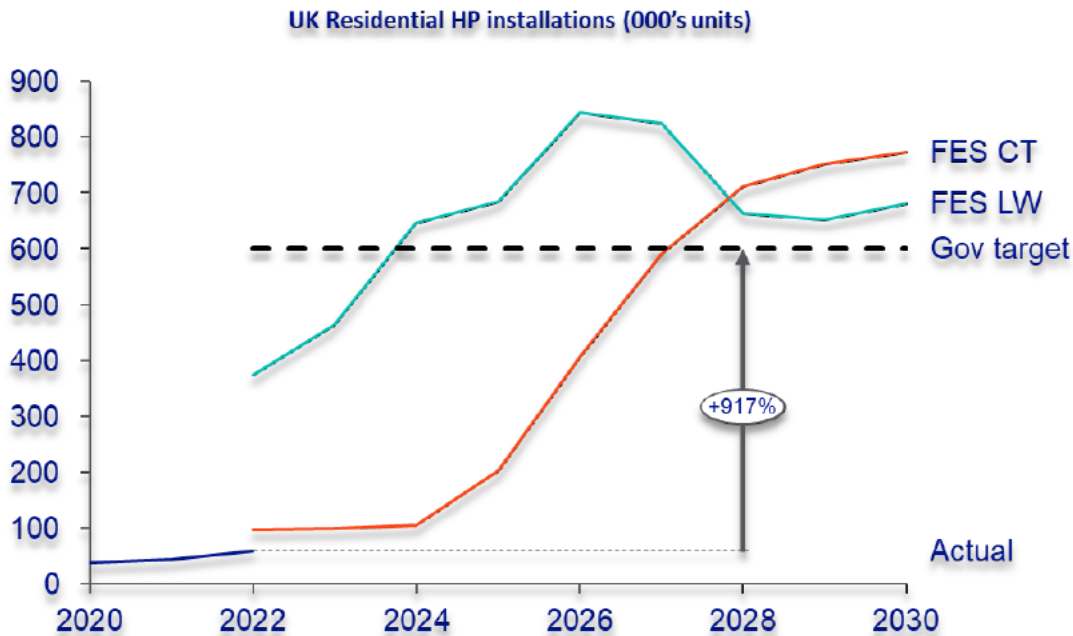


Figure 1: Installation of residential Heat Pumps (HP) vs UK Government target and FES (CT and LW)

50:50 Constraint Split

Our response to this is covered in Question 4.1

Run Hours

The underlying run hours across all four FES scenarios have been derived using capability and availability data as described by Ofgem but should not be used to determine the preferred option. FES scenarios use averages across a long period of time and therefore do not account for exceptional years. The uncertainty surrounding FES and the recent developments around LNG supplies indicate these assumed hours could be very different from the forecast. This has been seen at Wormington with all three units having ran over 1,000 hours so far this reporting year.

The difference in run hours between two of the four FES scenarios beyond 2030 shows the base requirements for resilience at Wormington, which cannot be covered by a restricted second gas unit. Taking into consideration the updated forecast we have seen on LNG supplies, a higher running across all three units is more likely to happen before 2030.

Historic run hours as detailed by Ofgem in the consultation do not reflect recent changes in how the gas transmission network had to be ran in 2022. Run hour requirements accounting for high impact events, such as VSD outages and flexible gas supply into GB, cannot be ignored by using probabilistic run hours based on FES scenarios. 2022 requirements illustrate credible circumstances we need to plan the network to.

Construction Outages

A key advantage of Option 10 identified in the FOSR was to maximise short-term availability at the Wormington Compressor site as there would be fewer outages during construction and commissioning than would be the case with options involving existing unit modification/retrofit. Ofgem do not believe that the difference between Option 10

and Option 7 in this regard has a material impact on our assessment. Option 7 involves additional brownfield scope requiring outages, Option 10 does not.

Due to the critical nature of the Wormington compressor station and its role in supporting import flows from Milford Haven, as well as South Wales and South West demand, planning and managing construction/commissioning scope in these outages will be a challenge. For example, in a period when all units at Wormington were available during Summer 2022, the Milford Haven Baseline was reduced due to the difference in the network's capability and the terminal's capacity during low demand periods. Although a reduction in outages is not a primary decision criterion, it should be considered as it would be beneficial to the market and our customers.

LNG Forecast

Our response to this is covered in Appendix 2.

Net Present Value

Ofgem state that NGGT's FOSR lists the Net Present Value for each option relative to the baseline 'do nothing' option and that they consider that it is better to report Net Present Value in absolute terms. Ofgem prefer this approach as it makes clear that the capital investment being considered is to ensure compliance with an environmental regulation and does not generate value in its own right and the objective is therefore to reduce compliance costs over the lifetime of the investment. We agree with this statement, and we have provided both measures (absolute and relative) in the FOSR and have used these figures to support our decision making. The relative measure was included in the executive summary for ease of presentation.

Avon DLE Retrofit

Our response to this is covered in Question 5.2

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

We do not agree with Ofgem's preferred option regarding the second gas-driven turbine to be restricted to 500-hour EUD.

We agree with Ofgem's conclusion that in addition to the existing VSD, there should be at-least two gas-driven turbines due to the key role that the Wormington Compressor Station plays in Security of Supply and the need for resilience at such a critical part of the network.

South Wales is the most constrained area of the network, therefore any reduction in our ability to provide maximum capability is only going to exacerbate the situation. Capability and resilience should be maintained, as seen in the Steady Progression and System Transformation scenarios, with any LNG supply above these predictions further reinforcing the need for increased levels of resilience.

By restricting the second gas unit, Ofgem would be making the decision to reduce the resilience of the site, and network. As Ofgem recognise, new gas turbines will not only increase resilience, they also have lower emissions, greater fuel efficiency and a higher availability than the existing units.

We agree with Ofgem that, even though lower Capex options have been considered, including retrofit Dry Low Emissions (DLE) technology and derating the units using Control System Restricted Performance (CSRP), they are not viable options for Wormington.

Question 5.2: Do respondents agree with our proposals with respect to Avon Dry Low Emissions Retrofit technology?

We agree with Ofgem that once deemed available, retrofitting an existing Avon gas turbine with the DLE emission abatement technology is an effective means to reduce emissions and comply with legislation. For this reason, Avon DLE emission abatement retrofit was included within our option selection process and has been included within the option selection for our other compressor sites.

However, maintaining an Avon at Wormington is not the right solution. The significance of the site, as highlighted within this response, requires us to maintain or even increase the resilience and availability, and not to see a reduction. Any reduction to the site's resilience, through maintaining an Avon, will exacerbate the current constraint risks in that area of the network, negatively impacting the market and GB Security of Supply.

Ofgem agree with us that the 5% availability penalty applied to interventions that include a DLE retrofit to account for the immaturity of the technology. However, we disagree with Ofgem's view that it is excessive to apply this penalty to the whole duration of the assessment period. If Avon DLE becomes widely adopted across our Avons and those of other operators, this would result in further development and learning, increasing the availability. If there are a limited number of units in operation, then there is a low likelihood of further development, decreasing the availability.

Appendix 2 – LNG importation forecast

Supplies of LNG at Milford Haven are already at a significant level¹⁹, with external forecasts predicting LNG imports into GB will continue to increase beyond 2030, significantly above levels stated in FES 2021. This increase is due to the structural change in European gas market dynamics following the loss of Russian gas supply that has changed global gas trade flows. These developments have exacerbated the uncertainty around future supply and demand, underpinning the need to provide assurance to security of supply from key flexible entry points. LNG will become a critical gas supply for GB given our existing LNG import capacity, enabling fast market response and the ability to diversify our supply sources.

Figure 2 and Figure 3 below show the comparison between the two scenarios in FES 2021 with the highest LNG imports, actual imports, and [REDACTED] latest LNG forecast. Actual LNG imports to GB in 2022 have been significantly higher than the FES outlook, and LNG flows remaining high out to 2040 in [REDACTED] latest forecast²⁰. LNG supplies around or above that forecast in either System Transformation or Steady Progression would further reinforce the requirement for two new units at Wormington compressor station.

Given the high uncertainty in the energy landscape and FES scenarios, there is a high probability of no, or very high priced, gas imports from Europe (due to the loss of Russian pipeline supplies, diverting Norwegian gas away from GB and reducing interconnector imports). LNG offers the only significant flexible supply option, supplying large volumes of gas into GB throughout the year.

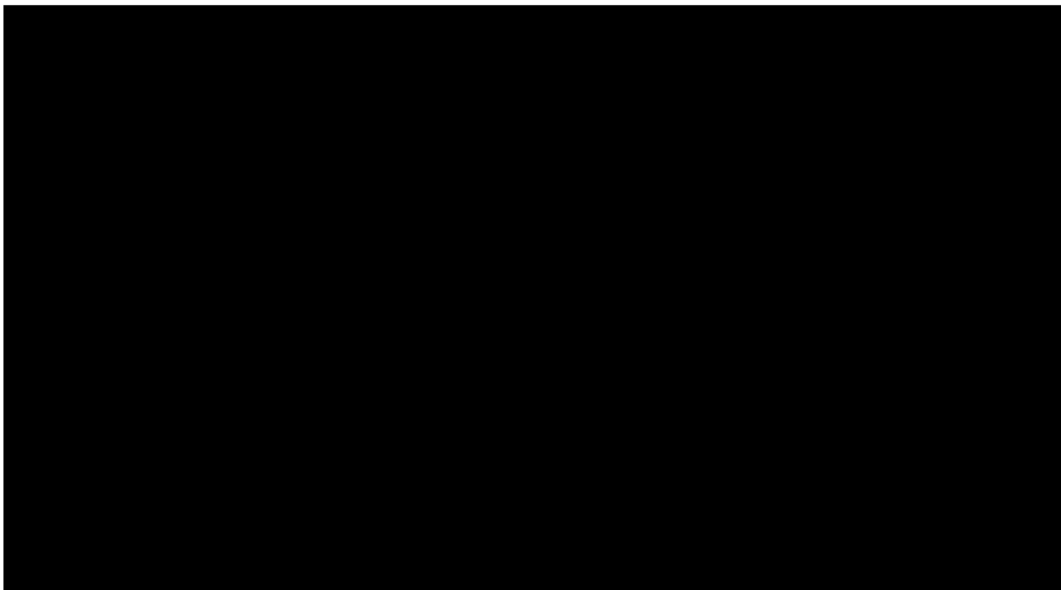


Figure 2: UK LNG imports (FES 2021 - LNG only)

¹⁹ Furthermore, NGGT has received a "Planning and Advanced Reservation of Capacity Agreement" (PARCA) request to increase entry capacity by 17% at Milford Haven (25% at South Hook LNG Terminal). The associated Needs Case was approved by Ofgem in December 2021.

²⁰ [REDACTED] UK LNG import outlook from their Q4 2022 Long Term European Outlook

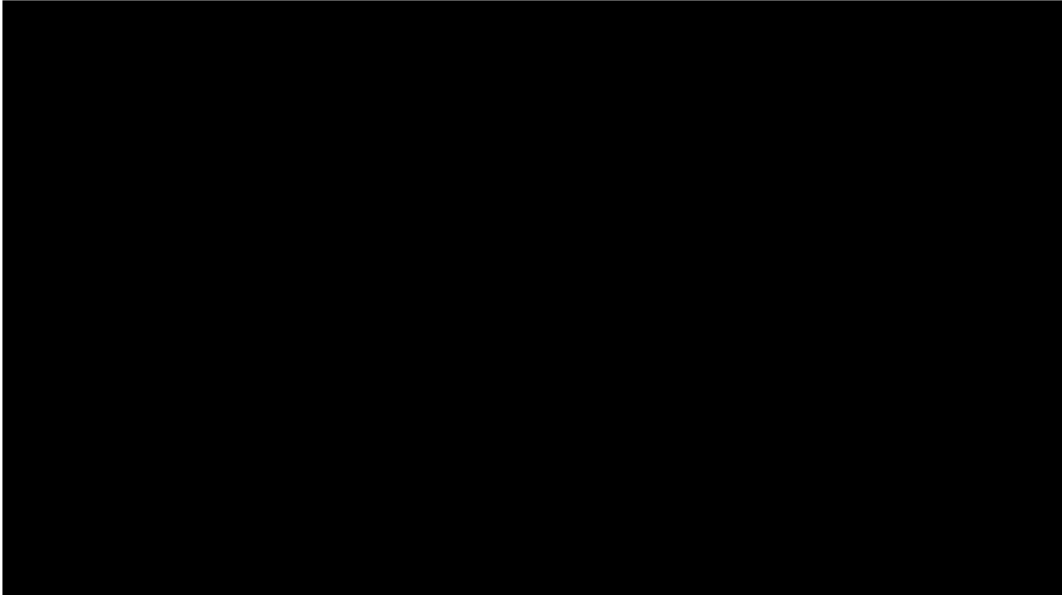


Figure 3: UK LNG imports (FES 2021 range includes LNG + Generic imports)

To understand the potential impacts on Security of Supply, we have created several scenarios based on this year's actual data. The capability has been uplifted due to the WGN upgrade, and the availability was that which was assumed in our FOSR. The WGN upgrade increases our overall capability and the flows at which Wormington compression is required.

Tests were then carried out to determine the impact of raising flows at the South Hook LNG terminal in line with the additional capacity delivered through the PARCA, the impact of an extended outage of unit C and a 5% reduction in the availability of unit C and the new gas unit.

In all four scenarios, Table 1, the required run hours on the third unit exceeds 500 hours under normal operating circumstances (3rd unit not restricted to 500hrs Essential Use).

Table 1: Security of Supply scenarios

Flows	Capability	Availability	Unit C	New Unit	3rd unit
Current Year + PARCA	Current + WGN Upgrade	RAM Model	2265	2354	612
Current Year	Current + WGN Upgrade	Unit C 7-month outage	909	1620	1071
Current Year + PARCA	Current + WGN Upgrade	Unit C 7-month outage	1322	2354	1556
Current Year + PARCA	Current + WGN Upgrade	RAM Model - 5%	2152	2237	843

Appendix 3 - 500 hour limitations and Essential Use classification

Units restricted to 500 hours per year under Emergency Use Derogation²¹, or to 17,500 hours under Limited Life Derogation²² can be classed as Essential or Emergency Use for our operating strategies. This removes the use of the compressors for standard operation, where they can only be run to prevent commercial constraints (Essential Use), or exit constraints (Emergency Use) on the network. Restricting a compressor at Wormington under 500-hour EUD would reserve its operation for Essential Use only.

Limited operation of a compressor would negatively impact its availability due to faults not becoming known until utilisation, when its operation is vital. Failure to operate when required would lead to constraints. The inability to reliably accept gas into the network puts the Security of Supply for GB at risk. A reduction in supply would result in increased gas prices, impacting GB's economy and consumer bills.

A minor or major failure of the VSD (as stated in Appendix 7) during a peak demand day would require operation of both gas driven compressors to cover baseline. In such a scenario, a run-hour restriction would have a significant impact on NGGT's ability to meet our obligation and manage flows.

Parallel running of A and B unit exceeded 500 hours at the start of 2022 when the VSD was unavailable. Table 2 below shows that unit A was operated for 1,207 hours and unit B 838 hours, both significantly over 500 hours. 500 hours of running amounts to 21 days in one month. This is calculated assuming 500 hours of running over a rolling three-year average. The legislation allows a maximum of 750 hours running per year as long as a 500 hour average across a rolling three years is not exceeded. We believe 500 hours is the correct planning assumption and a 750 hours maximum would need to be managed by short-term operational concerns.

Table 2: Wormington run hours in 2021/22

Gas Year	Unit A	Unit B	Unit C	Total
2021/22	1,207	838	507	2,552

²¹ Units can be ran for up to 500 hours per year, on a five year rolling average, up to 750 hours in a single year. This derogation currently has no end date.

²² Applicable for LCPD units only. Units can be ran for up to 17,500 hours until they have to cease operation. Units have to cease operation by 31 December 2023, when the 17,500 allowance expires.

Appendix 4 - Technology Readiness

Wormington Compressor Station is required to be MCPD compliant by 1 January 2030. Therefore, a solution needs to have been operationally accepted by this deadline. Delaying an investment decision increases the risk of not having an appropriate solution in place, in turn increasing the risk of a constraint.

Only technology that has been approved and is classed as “ready”, can be proposed for Wormington due to the site’s criticality, as 500 hours is not a suitable fallback option as described above. Two technologies that are being assessed for their viability are CSRP and DLE retrofit. Although these technologies have the potential to provide a lower cost alternative than new units at complying with MCPD, they are not classed as available, and nor are they the ideal solution for the site.

For a critical site, such as Wormington, long term Avon operation increases the risk (compared to new units) due to age related fatigue, loss of engineering experience, dwindling support, lack of field service capability, minimal OEM support, low spares availability (often refurb only) and an inability to purchase OEM long term support packages. New Unit OEMs include support agreements, remote monitoring, online support, and continued development which are not available for the older Avon (no longer included in Siemens product line). Again, these factors should be a key consideration in the selection of suitable options alongside cost benefit analysis.

Appendix 5 – VSD Resilience and Single Points of Failure

Asset Health Investment has been included within our FOSR to improve the VSD availability from 82% to 86.6%. Although this is high, there will still be periods of planned and unplanned outages. There are multiple complex points of failure for VSD systems, including but not limited to interruption of their power supply and faults on the ancillary systems and motor.

NGGT has nine electric-driven compressors across the fleet, seven of these are VSDs from Siemens, ranging from 16 to 35MW. Historically, extended outages on our VSD fleet have been caused by major failures where overall repair time, including mobilisation of spare parts, took months. If spares are sourced to increase availability, these would be unit specific, non-transferable with the units of other sizes²³.

Minor outages can also be caused through minor failures where spare parts are not available and need to be ordered, leading to longer repair times.

²³ [REDACTED]

Appendix 6 – Supporting evidence for financial and operational impacts

Impact to Wholesale GB Gas Market

To ascertain an impact to wholesale markets from the potential supply loss from Milford Haven region, external analyst [REDACTED] were asked to do some analysis on their most recent market outlook (base case) to provide an indication of potential market impact if such supply deficits would occur in today's market. In summary the following analysis highlights the likelihood of an impact on the wholesale gas price to around £100m over a 5 day period from a 20mcm/d constraint at Milford Haven over the same 5 day period, based on current prices. Such wholesale costs would be expected to flow through to consumer prices in addition to the direct constraint costs.

[REDACTED] used their fundamental S/D model to consider the following cases:

Table 3: [REDACTED] S/D model

[REDACTED]

The analysis focused on balancing the GB gas market to meet demand from other available supply sources, factoring in the cost of supply based on supply merit order curves, cost of secondary capacity at LNG terminals, but assuming perfect market competition (i.e.no commercial optimisation). Breakdown of the GB S/D balances and wholesale gas hub price views in their base case and the scenario analysis are as follows:

Base case: Average daily GB gas balances (mcm/day) for Winter (January 23) and Summer (August 23) periods from [REDACTED] Q4 2022 Short Term Market Outlook

Table 4: Base case

[REDACTED]

Scenario 1: Outage resulting in a reduction of 5mcm/d of supply loss from Milford Haven to NTS over 5 days

Table 5: Scenario 1

[REDACTED]

Scenario 2: Outage resulting in a reduction of 20mcm/d of supply loss from Milford Haven to NTS over 5 days

Table 6: Scenario 2

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Scenario 3: Outage resulting in a reduction of 50mcm/d of supply loss from Milford Haven to NTS over 5 days

Table 7: Scenario 3

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The chart below shows the impact to the average monthly wholesale prices for the above supply loss cases – this is the delta in calculated monthly average price for NBP and TTF hubs for the scenarios vs. [redacted] base case for that period. The impact on the gas forward curve is not captured in this analysis.

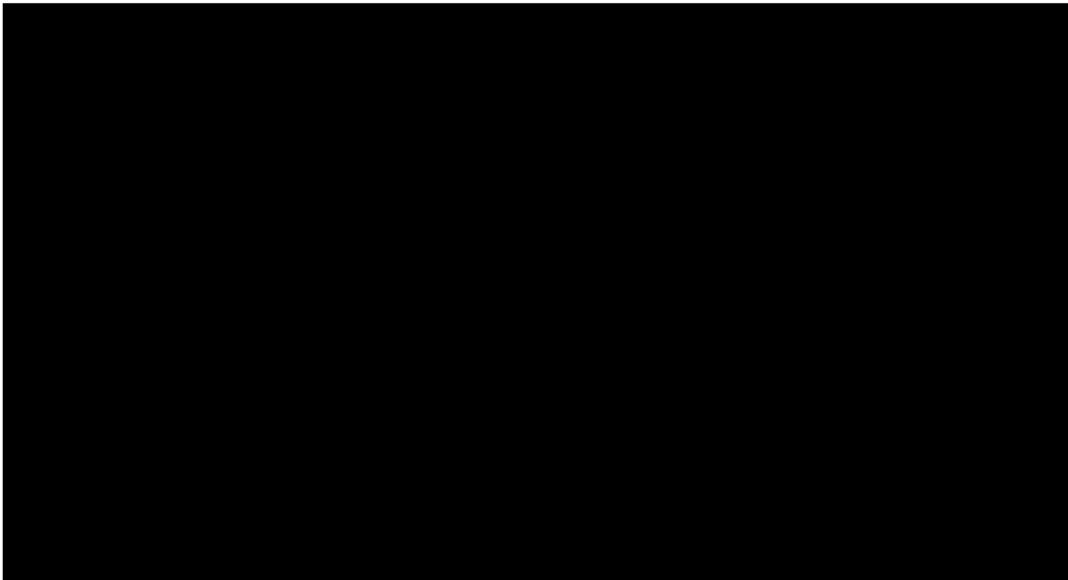


Figure 4: Wholesale Gas Price Impacts (Milford Haven supply loss)

Based on [redacted] view for GB gas demand for the months analysed (see above), and the calculated NBP price impact from the supply loss scenarios, an indicative total wholesale market impact is shown in the chart below.



Figure 5: Indicative NBP market impact (Milford Haven supply loss)

To demonstrate those impacts we have analysed wholesale gas prices using a scenario with a shortfall of 10-15 mcm/day on LNG import, which considers a shortfall post WGN driven investment. This is leading to a wholesale gas price impact of around £76m over 5 days. The £76m is pro-rated from £101m with a shortfall of 20 mcm/day on a summer day (see Figure 5).