Annex
A16.12 Peterborough and Huntingdon Compressors Engineering Justification Paper
December 2019

As a part of the NGGT Business Plan Submission

nationalgrid

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1. Executive Summary

1.1 This paper sets out our proposals at the Peterborough and Huntingdon compressor sites to ensure sufficient network capability, to fulfil our customer and operational requirements, whilst also complying with the Medium Combustion Plant Directive (MCPD) emissions legislation. This justification paper supports the proposals in chapter 14 of the NGGT RIIO-2 business plan "I want to take gas on and off the transmission system where and when I want", and chapter 16 "I want to care for the environment and communities". This justification paper should be read in conjunction with the Compressor Emissions Compliance Strategy (CECS) in Annex A16.05 to the business plan.

1.2 Peterborough and Huntingdon are considered in a joint justification paper as they have a significant interaction on the network in a range of demand and supply conditions but are predominantly used for bulk transmission of gas to support extremity pressures in the South East and South West, particularly during winter demand and peak 1-in-20 demand conditions. Consequently, both are high utilisation sites with average run hours of 5,400 hours and 2,600 hours per year respectively. The sites are interactive and can provide some resilience to each other. The central location of the sites mean they can also be used for a wide range of other purposes; such as Peterborough being key in maximising entry capability at a number of the larger entry points across the country. A reduction in the flow through Peterborough has a knock-on impact to the level of flow through all compressors upstream and downstream of Peterborough (Bishop Auckland, Hatton, Huntingdon and Lockerley) which are also used to support Southern demand. There are no other credible options to re-route this gas on the NTS.

1.3 Both sites currently each have three Rolls Royce Avon 12MW gas-driven compressors installed, which are not compliant with the MCPD. It is planned that by 2021 both sites will have an additional two compliant 15MW Solar Titan units each installed to deliver emissions reductions under the Industrial Pollution Prevention and Control Directive (IPPCD). Our network modelling assumes that these are in place and operational by the start of RIIO-2. The National Grid standard is that the proving period for new compressors, after asset acceptance, is two winters. This is to allow for resolving of any start-up/commissioning issues, particularly ahead of decommissioning any existing units on site.

1.4 Peterborough is critical to supporting 1-in-20 demand in the South West for a sustained period beyond 2030. Our forecasts of run hours indicate a sustained requirement for around 500 hours of resilience operation at Peterborough.

1.5 Due to their interactive nature, the options considered for MCPD compliance were compared holistically across Peterborough and Huntingdon in a Cost Benefit Analysis (CBA). This compared the costs of installing and maintaining the proposed units, together with estimates of constraint costs associated with the differing levels of capability and availability under each alternative option, to arrive at the lowest overall cost to consumers. **Table 1** summarises the broad options assessed for both sites. We used the 2018 Future Energy Scenarios (FES), Steady Progression scenario in our analysis as our base case for the CBA with sensitivities being run against the other three scenarios, these are given in **Table 2. Table 2** shows the long list of CBA options derived from the broad list shown in **Table 1.** For example, our chosen Option 6 is made up of Option 2 for Huntingdon and Option 3 for Peterborough.

1.6 We have not assessed Selective Catalytic Reduction (SCR) at either site in the cluster analysis as it is unlikely to be a viable option.

1.7 Our proposal is to proceed to Front End Engineering Design (FEED) with the option of building one new, gas–driven compressor unit (of similar rated power to the existing

Avon units - approximately 15MW) at Peterborough and derogating one unit at Huntingdon. Recognising the uncertainty around the exact solution required, and the variables in the FES 2018 scenarios, we are proposing that investment taking place post FEED be subject to an Uncertainty Mechanism (UM) process. We are not requesting baseline funding for expenditure post-FEED. Allowances and the price control deliverable will be set through the reopener process. Please see Annex A3.02 for further detail on our UM proposal.

Table 1: Broad Options Assessed and CBA Cost Inputs (2018/19 price base)

Cost (£m)	**P&H Combined Option**			
	(Counterfactual) 0 - 500 Hr Derogation x 3	1 - 500 Hr Derogation x 2	2 - 500 Hr Derogation x 1	3 - One new Gas Turbine
Operating and constraint costs are based on the combination of options at both Huntingdon and Peterborough.				
Total CAPEX cost (Pete.), including the below*:	[redacted]			
Total CAPEX cost (Hunt.), including the below*:				
• Total installed costs				
• Asset health costs over 25 years (Pete.)				
• *Asset health costs over 25 years (Hunt.)*				
• Decommissioning costs (similar at Pete. and Hunt.)				

*Different asset health conditions at Peterborough and Huntingdon hence the different asset health and Total Capex costs

Table 2: CBA Results – NPV relative to the counterfactual[1]

Short Name	**Description**	**Central Case Steady Progression**	**High Sensitivity Two Degrees**	**Low Sensitivity Consumer Evolution**	**Additional Sensitivity Community Renewables**
Option 0	0 - Hun/Ptb 3 on 500	£ 0m	£ 0m	£ 0m	£ 0m
Option 1	1 - Hun/Ptb 2 on 500	£20.2 m	£20.4 m	£20.4 m	£20.5 m
Option 2	2 - Hun/Ptb 1 on 500	£37.5 m	£39.4 m	£40.8 m	£40.9 m
Option 3	3 - Hun/Ptb 1 New	-£46.9 m	-£50.4 m	-£46.7 m	-£49.2 m
Option 4	4 - Hun 3*500/Ptb New	-£20.4 m	-£22.4 m	-£20.6 m	-£22.6 m
Option 5	5 - Hun 2*500/Ptb New	-£8.8 m	-£11.0 m	-£8.7 m	-£10.6 m
Option 6	6 - Hun 1*500/Ptb New	£0.2 m	-£0.8 m	£2.3 m	£0.1 m
Option 7	7 - Hun New/Ptb 3*500	-£26.7 m	-£27.3 m	-£26.0 m	-£27.1 m
Option 8	8 - Hun New/Ptb 2*500	-£17.9 m	-£18.6 m	-£17.4 m	-£18.0 m
Option 9	9 - Hun New/Ptb 1*500	-£10.1 m	-£9.7 m	-£7.7 m	-£9.0 m
Option 10	10 - Hun 3*500/Ptb 2*500	£8.7 m	£8.6 m	£8.8 m	£8.5 m
Option 11	11 - Hun 3*500/Ptb 1*500	£17.3 m	£17.7 m	£18.0 m	£18.3 m
Option 12	12 - Hun 2*500/Ptb 3*500	£11.5 m	£11.6 m	£11.8 m	£11.7 m
Option 13	13 - Hun 2*500/Ptb 1*500	£28.7 m	£29.4 m	£29.9 m	£29.9 m
Option 14	14 - Hun 1*500/Ptb 3*500	£20.9 m	£21.9 m	£22.6 m	£22.6 m
Option 15	15 - Hun 1*500/Ptb 2*500	£29.5 m	£30.5 m	£31.3 m	£31.3 m

1.8 By ensuring suitable levels of compression are available at Peterborough and Huntingdon it is possible to place derogations on the non-compliant MCPD units at Diss, Chelmsford and Cambridge as well as limit any future investment.

1.9 At the Peterborough site, the current estimated cost for delivery of the MCPD compressor unit is [redacted] (including FEED) in RIIO-2 and [redacted] in RIIO-3. The cost for decommissioning the two IPPC replaced MCPD units in RIIO-2 is [redacted] while the cost of decommissioning the remaining non-compliant unit is [redacted] in RIIO-3. Delivery will be measured through a Price Control Deliverable (please see annex A3.01 for further information).

2.0 We will undertake a Preliminary Best Available Techniques (BAT) assessment on the options for MCPD compliance at King's Lynn. This established, stepwise assessment process is underpinned by an environmental cost-benefit analysis methodology, which draws together environmental and operational priorities to support decision making. The assessment will be undertaken independently from the CBA analysis

[1] Note that these calculated NPVs assume a capitalisation rate of 73.5% as set out in CECS (Annex A16.05). This capitalisation rate has now been updated, and therefore there may be a minor mismatch between quoted NPVs between this document and the associated CBA (Annex A16.11). Please note that this does not affect the final proposed option. The impact of the updated capitalisation rate is reflected in the CBA document.

and is a different methodological approach; it however incorporates consistent assumptions on cost, investment cases and future gas supply predictions.

2.1 In this paper, a 'Medium' unit refers to a unit of similar rated power to an existing Avon compressor unit – approximately 15MW. A 'Large' unit refers to a unit of similar rated power to an existing RB211 compressor unit – circa 27MW+.

2. Summary Table

The costs in this summary table and throughout the document are in 2018/19 price base.

Name of Project	Peterborough/Huntingdon MCPD		
Scheme Reference	TBC		
Primary Investment Driver	Compliance with MCPD legislation		
Project Initiation Year	2019		
Project Close Out Year	2030 Peterborough New Build, 2024 Huntingdon Decommissioning		
Total Installed Cost Estimate (£)	[redacted] (one new unit) (decom of 3x units at Peterborough and 2x units at Huntingdon)		
Cost Estimate Accuracy	P50		
Project Spend to date (£)	0.04m		
Current Project Stage Gate	4.1 – Establish Portfolio		
Reporting Table Ref	TBC		
Outputs included in RIIO-1 Business Plan	IPPC project included in RIIO-1		
Spend apportionment	**RIIO-1**	**RIIO-2**	**RIIO-3**
	£0.04m (spend to date)	[redacted]	[redacted]

3. Project Status and Request Summary

3.1 Existing levels of capability are required to be maintained at Peterborough and Huntingdon compressor sites. National Grid is requesting funding at Peterborough and Huntingdon to ensure this capability is compliant with the Medium Combustion Plant Directive (MCPD). Given the strong interactions between our Peterborough and Huntingdon compressor sites, we have considered options across both sites in a single assessment. The six existing compressor units across Peterborough and Huntingdon are impacted by the legislation. Further information on the MCPD and legislative drivers can be found in the Compressor Emissions Compliance Strategy (CECS) in annex A16.05 of the business plan.

3.2 In our business plan, we have proposed proceeding to FEED with Option 6 – build one new gas–driven compressor unit (of similar rated power to the existing Avon units - approximately 15MW) at Peterborough and one derogated unit at Huntingdon in preference to the highest NPV option (Option 2, one derogated unit at each site). Proceeding to FEED in the RIIO-2 period ensures this option can be delivered in time to achieve the benefits of this option and also allows significant flexibility if, at a later stage with further information on the supply/demand pattern and volatility, it becomes clear that the Option 6 level of investment is not required, as it could be converted to another option. We are proposing an associated UM as set out in Annex A3.02. We are not requesting baseline funding for expenditure post-FEED. Allowances and the price control deliverable will be set through the reopener process. Key proposed timelines for this are as follows, full information on each stage is set out in annex A3.02:

- FEED feasibility – January to June 2024

- Ofgem touchpoint – July 2024
- Tender process & BAT – August 2024 to January 2025
- Reopener (with Ofgem) – February – May 2025
- Decision required – June 2025

3.3 Four new compressor units are currently being delivered across Peterborough and Huntingdon, under the Industrial Pollution Prevention and Control (IPPC) component of the Industrial Emissions Directive (IED), current estimated completion date being 2021 at both sites. The four IPPC compressors are outside the scope of this justification paper. At each site, the two new IPPC units will take over the primary duty, leaving the Avon units to resilience status. Assessment of the requirements of both sites has demonstrated that the four MCPD non-compliant Units A and B each site can be decommissioned; provided that Peterborough Unit C is replaced and Huntingdon Unit C is retained on 500hr derogation for resilience.

3.4 At the Peterborough site, the current estimated cost for delivery of the MCPD compressor unit is [redacted] (including FEED) in RIIO-2 and [redacted] in RIIO-3. The cost for decommissioning the two IPPC replaced MCPD units in RIIO-2 is [redacted] while the cost of decommissioning the remaining non-compliant unit is [redacted] in RIIO-3.

3.5 At the Huntingdon site, the current estimated cost for delivery of MCPD compliance is [redacted] for decommissioning the non-compliant Units A and B in RIIO-2.

3.6 The project is currently in stage 4.1 ('Establish Portfolio') of the Network Development Process (ND500) – a process aimed at defining and managing the project lifecycle from inception to closure, ensuring we meet minimum requirements for each project phase (for more information refer to CECS). Decommissioning of the four MCPD non-compliant Units A and B at Peterborough and Huntingdon sites is planned to start in 2023 once the new IPPC units are fully operational. The National Grid standard is that the proving period for new compressors, after asset acceptance, is two winters. This is to allow for the resolution of any commissioning issues, particularly ahead of decommissioning any existing units on site. Decommissioning of Peterborough Unit C is planned to start in 2029. Forecasted network needs have been considered in the selection of this decommissioning option.

3.7 We have considered and costed several options across Peterborough and Huntingdon, which would meet our operational requirements. These options have been costed from both an asset investment and a commercial perspective. Our recommended solution is supported by a CBA which has considered investment costs for compressors; the constraints and contracts cost; and compressor running costs.

3.8 Our proposed solution across the two sites was allows us to minimise investment in Diss, Chelmsford and Cambridge through RIIO-2 and for the potential to decommission units at these sites during RIIO-3.

3.9 Preliminary BAT analysis will be undertaken to input into FEED to support our CBA and to feed into the decision-making process. Preliminary BAT analysis is an assessment of the available techniques best placed to prevent or minimise emissions and impacts on the environment. Please refer to the CECS document for more information.

3.10 Related emissions legislation compliance work was undertaken at Peterborough and Huntingdon sites during RIIO-1 with regards to compliance with the IPPCD. Learnings from this project will feed into our RIIO-2 compressor emissions compliance projects. More information on this can be found in CECS.

4. Problem / Opportunity Statement

4.1 The purpose of this project is to comply with the MCPD at Peterborough and Huntingdon compressor sites, ensure ongoing compliance with the 1-in-20 design standard and to provide the capability that the network requires in the most cost-effective way for end consumers. For more information on the MCPD, please refer to CECS. Two new compressor units are currently being built at each site in accordance with the IPPC element of IED and are therefore outside the scope of this justification paper. This justification paper assesses the requirement and most economic and efficient method of providing necessary resilience at the sites and allow access for planned maintenance without disrupting our customers' requirements to flow gas on and off the network when they want.

4.2 Each compressor station consists of three Rolls Royce Avon compressors (Peterborough Units A, B and C and Huntingdon Units A, B and C). The Avon units can operate in series or parallel at each site and are all affected by the MCPD. They will be limited to 500 hours annual usage (on a rolling five-year average) from 1 January 2030 or require decommissioning. Current build of the four new compressor units, under IPPC, is estimated to be completed by 2021. Once these IPPC units are operational then the four MCPD non-compliant units A and B at Peterborough and Huntingdon sites can be decommissioned.

4.3 **Table 3** and **Figure 1** summarise the site compressor assets, covering those currently in operational use and those planned to be constructed via a live IPPC funded investment project.

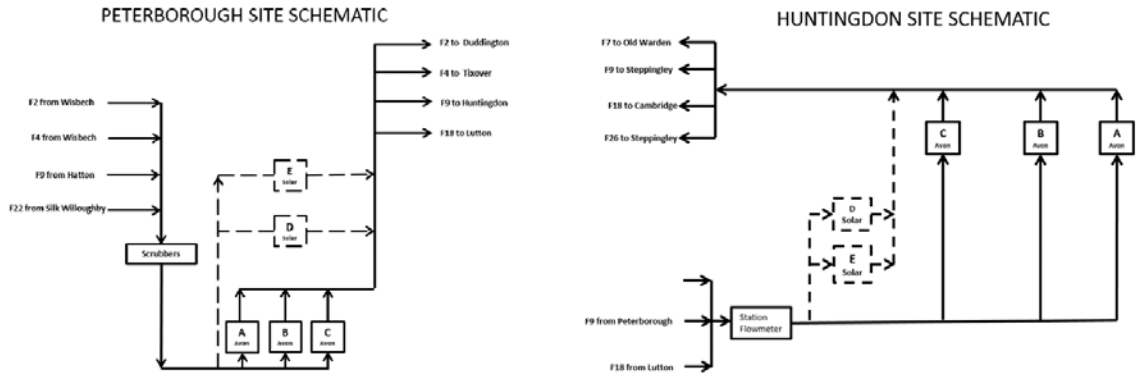

Figure 1: Peterborough and Huntingdon Site Schematics

Table 3: Existing Assets Summary

Unit	Engine	Fuel Type	Power Base (MW)	Installation Date	Minimum Operational Flow (mscm/d)	Nominal Capacity (mscm/d)	Maximum Discharge Pressure (barg)
Peterborough							
A	RR/Avon	Gas	12.34	1973	14	73	70
B	RR/Avon	Gas	12.34	1973	16	73	70
C	RR/Avon	Gas	12.34	1978	7	73	70
D	Solar Titan	Gas	15.30	2021	-	-	-
E	Solar Titan	Gas	15.30	2021	-	-	-
Parallel Operation	A, B or C	Gas	24.68	-	-	140	70
Huntingdon							
A	RR/Avon	Gas	12.34	1989	12	55	75
B	RR/Avon	Gas	12.34	1989	12	55	75
C	RR/Avon	Gas	12.34	1992	17	55	75
D	Solar Titan	Gas	15.30	2020	-	-	-
E	Solar Titan	Gas	15.30	2020	-	-	-
Parallel Operation	A, B or C	Gas	24.68	-	-	105	75

4.4 Peterborough and Huntingdon are predominantly used for bulk transmission of gas to support extremity pressures in the South East and South West (see location in relation to the rest of the network in **Figure *5***) particularly during winter demand (>250mscm/d) and peak 1-in-20 demand (460 mscm/d) conditions. The central location of the sites means they are also used for a wide range of other purposes, such as:

- facilitating baseline entry flows at Bacton by moving gas away from the terminal;
- moving gas towards Bacton under high Interconnector (IUK and BBL) export conditions;
- moving gas away from South Wales under high Milford Haven flow conditions;
- moving gas towards South Wales under low Milford Haven flow conditions;
- moving gas away from the North West and West Midlands under high North West storage import flow conditions;
- moving gas towards the North West and West Midlands under high North West storage export flow conditions;
- supporting movement of gas from the North East into the Southern part of the network;
- providing network resilience by acting as back-up stations in case there are operational issues at Hatton or Wisbech;
- facilitating maintenance and planned outages in the central and southern parts of the network.

Figure 2: Peterborough and Huntingdon Locations

4.5 The ND500 stage gates (for full explanation please refer to CECS), ensure we meet minimum requirements for each project phase. The indicative dates for the key milestones are based on our current experience of investment in new compressors. Milestone dates have been set by scheduling these projects against other planned investment work. The start of Original Equipment Manufacturer (OEM) design and build phase at Peterborough is 2025 with operational acceptance and project closure in 2030; and the decommission phase at Huntingdon is 2023 with project closure in 2024. Our key milestones are estimated around this time scale, as shown in **Table 4**. **Table *30*** in Section 8.8 provides more detail.

Table 4: Key Milestone Dates for Peterborough & Huntingdon Compressor Sites

Cycle	Network Development Stage Gates		Indicative Dates	
			Peterborough New Build	**Huntingdon A and B Decommission**
Pre-FEED Stage 4.0 and 4.1	**T0 – T2**	• Generation of Need Case • Accept Need Case • Initial Sanction • Define Strategic Approach & Outputs Required to Deliver • GT Handover to Delivery Unit	April 2019 - June 2024	April 2019 - June 2022
FEED Stage 4.2	• **F2** • **F3**	• FEED Sanction and Feasibility Sanction • Includes BAT assessment and Compressor Machinery Train selection • Reopener process • Agreement to Proceed to Conceptual Design • Conceptual Design Sanction and Sanction of long lead items	• June 2024 • June 2025	June 2022
Tender Award Stage 4.3	**T4**	• Scope Freeze	September 2026	December 2023
Project Execution Stage 4.4	• **F4** • **T5**	• Detailed Design AND Build Sanction • DDS Challenge, Review & Sign off • Maintenance Requirements Identified	• September 2026 • June 2027	December 2023
Acceptance Stage 4.5	• **T6** • **T5**	• Post Commissioning Handover to GT; • Operational & Maintenance Complete or Planned (Operational Acceptance) • Project Closure	• June 2029 • March 2030	• March 2024 • December 2024

4.6 Project success will be confirmed by operational acceptance of the new assets at Peterborough by 2029, meeting customer demands throughout construction, complying with MCPD legislation and by the safe and full decommissioning of the five Avon units (Peterborough Units A, B and C and Huntingdon Units A and B) by 2024,. Delivery will be measured through a Price Control Deliverable from a regulatory perspective. Please see Annex A3.01 for more information on this.

4.7 Challenges to this project are summarised below and elaborated further in **Table *31***:

- Outages;
- Land; and
- Contracts.

4.8 Circumstances that would lead to a change in the need or option for this project are summarised as:

- Changes in supply and demand patterns beyond the FES 2018;
    - Investment or new discoveries in UK gas production (UKCS, Shale and green gas) reducing LNG important dependency.
    - Changes in the interconnectors' operating models or services that either increase or decrease supplies from Europe.
    - UK moving towards a Hydrogen market sooner than 2030 and to a bigger scale.
    - Closure of storage sites in the South West that are no longer economic requiring additional compression to support demand.
    - Changes in geographical demand relative to today due to areas adopting different technologies for heating. This could reduce compression requirements areas in the South adopt cleaner fuels for heating or increase it if they have access to Carbon Capture Utilisation and Storage (CCUS) schemes that decide to convert to Hydrogen.
    - How the government implements the findings of the Climate Change Act 2008 (2050 Target Amendment) from May 2019;
        - Use hydrogen and electrification to replace fossil fuel.
        - Use electricity /hydrogen for transport without an interim biofuel step.
- Changes in European markets;
    - Conversion of European power stations to gas which could reduce imports through the interconnectors and increase UK dependency on LNG.
    - Europe and Norway move to a Hydrogen based market at different timescales to the UK. This reduces the flows through the interconnectors and increases the UK requirement for LNG to meet demand.
    - New pipelines from Russia reducing LNG requirements in other parts of the world results in additional cargoes to the UK.
- Changes in the global LNG markets;
    - Changes in world markets could either reduce or increase the amount of LNG coming to the UK. Historically the Asian markets have influenced how much LNG comes to the UK e.g. the Japanese tsunami in 2007
- Failure to invest in the asset health at Cambridge, Chelmsford, Diss, Aylesbury and Lockerley resulting in reduced availability and an increase in the run hours at Peterborough or Huntingdon.
- Outcomes from the BAT assessment and tender which may influence the choice of technology, with alternative units being provided by OEMs such as proposed units offering hydrogen comparable compression.

4.9 For Peterborough, the recommended option is to build one new gas-driven compressor unit on adjacent, unused land within National Grid land, sized to meet the capability required for current and future customers. One of the Avon units would be maintained until the new unit has been operationally accepted, following which it would be decommissioned.

4.10 For Huntingdon, the recommended option is to decommission two MCPD non-compliant units and derogate one MCPD non-compliant unit. The timing of decommissioning the derogated unit will be decided through the network review process.

4.11 These recommended options will optimise unit availability and deliver the project objectives set out in the Executive Summary.

Related Projects

4.12 Projects related to Peterborough and Huntingdon MCPD are:

- Peterborough IPPC compressor upgrade project;
- Huntingdon IPPC compressor upgrade project;
- Hatton Large Combustion Plant Directive (LCPD) compressor upgrade / replacement project; (subject to reopener decision)
- Technology investments (e.g. cyber projects);
- Bacton redevelopment;
- Kings Lynn compressor and AGI;
- Wormington compressor; and
- The portfolio of RIIO-2 works to be delivered;

4.13 The scope of this project is only for costs associated with compliance with the MCPD. For Peterborough, these are costs for building one new MCPD unit and decommissioning three non-compliant units. For Huntingdon, these are costs for decommissioning two MCPD non-compliant units. Other costs such as asset health costs and operational running costs are included in the CBA, although we are not requesting funding through this paper.

5. Project Definition

Supply and Demand Scenario Discussion and Selection

5.1 To fully assess the project, a network assessment and a risk and constraint assessment was carried out. The network assessment was done to define the capability boundaries, for full explanation please see CECS. The boundaries feed into the constraint and risk assessment to define the associated costs. We have used the Steady Progression scenario from the FES 2018 as the base scenario for this proposal as it provides an appropriate central case for Peterborough and Huntingdon's expected use. Please see the Network Capability chapter and CECS Section 5 for full details.

Current Site Operation

5.2 Peterborough and Huntingdon are critical compressor stations on the National Transmission System (NTS). Peterborough is one of the most critical as it is located at a strategic multi-junction that conveys gas in multiple directions to meet geographical and national demand. Huntingdon is located at a strategic multi-junction able to support demands in the South East or South West. Without a resilient compression solution at Peterborough and Huntingdon we would not be able to comply with the 1-in-20 design standard in the South of the country.

5.3 The sites are predominantly used for bulk transmission of gas to support extremity pressures in the South-East and South-West, particularly during winter demand (>250m mscm/d) and peak 1-in-20 demand (480 mscm/d) conditions.

5.4 The wide range of uses for the sites means that they are some of the most utilised sites on the NTS, with 5,437 average annual run hours at Peterborough station and 2,594 average annual run hours at Huntingdon station over the last seven years. **Table 5** illustrates the annual run hours per unit.

Table 5: Peterborough and Huntingdon historic running hours - as reported in the Regulatory Reporting Pack

	Unit Running Hours (financial year)						
	12/13	**13/14**	**14/15**	**15/16**	**16/17**	**17/18**	**18/19**
Peterborough							
Unit A	3,227	2,911	2,370	522	30	2,143	827
Unit B	2,626	2,186	1,443	1,426	2,450	3,417	1,096
Unit C	2,007	2,076	1,576	482	3,220	1,558	466
Peterborough Total	**7,860**	**7,173**	**5,389**	**2,430**	**5,700**	**7,118**	**2,389**
Huntingdon							
Unit A	1,839	1,800	865	238	1,635	1,892	595
Unit B	2,008	1,237	295	451	1,381	1,082	864
Unit C	0	195	1,116	376	33	9	249
Huntingdon Total	**3,847**	**3,233**	**2,276**	**1,065**	**3,049**	**2,982**	**1,708**

5.5 The lower run hours in 2015 were due to extended outages on both sites between October and December. This was due to a trial assessing the impact on network operability if both Huntingdon and Peterborough were unavailable during winter conditions, which is when both sites have been used the most in the past (see **Figure 3** and **Figure *4***). The aim of the trial was to assess whether outages at the sites could be extended into the autumn/winter period to facilitate IPPC compliance construction work on site. The trial ended in January 2016 as the gas demand level increased and there was an operational need for both sites during the peak winter months.

5.6 The lower run hours in 2018/19 were due to the sites being on outage all summer and due to higher than usual LNG supplies at the Isle of Grain terminal. This reduces the need to move gas into the South East. The LNG market is difficult to predict and flows of the level seen in 2018/19 are not expected over the next few years but do increase in some scenarios as UKCS supplies decline.

5.7 **Figure 3** and **Figure 4** illustrate that Peterborough and Huntingdon are predominantly used during periods of high demand (>250 mscm/d) between October and March with minimal use during the summer months when national demand is lower.

5.8 The bar chart represents the monthly run hours (2014-2018) and the line graph represents national demand (mscm/d).

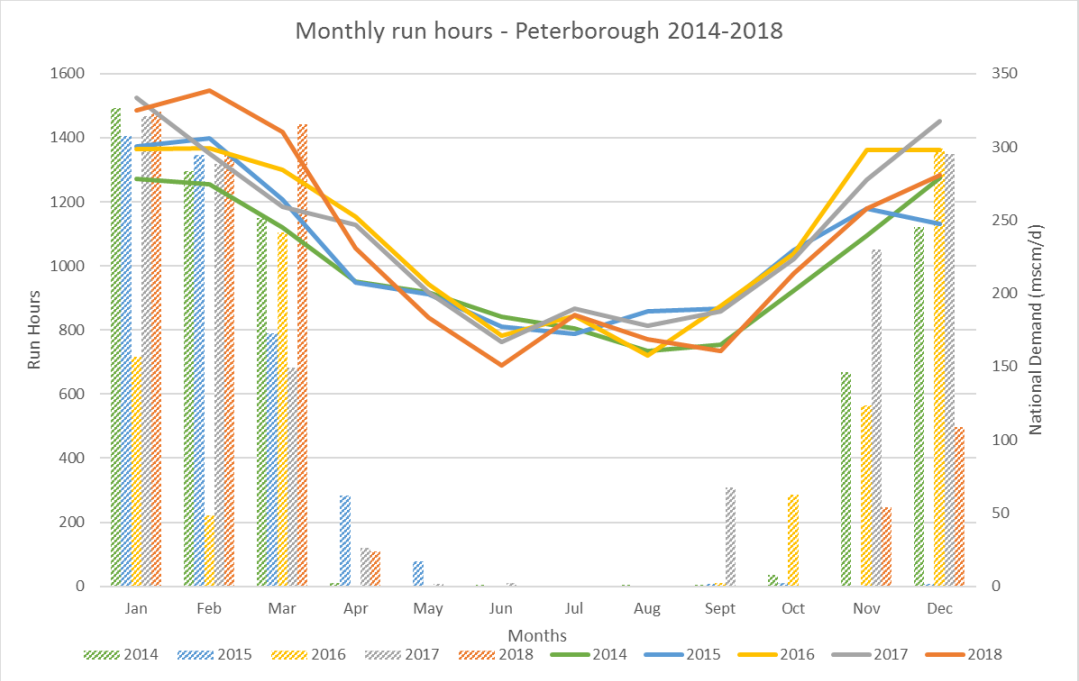

Figure 3: Monthly run hours against the average monthly National Demand level for Peterborough compressor station (2014-2018)

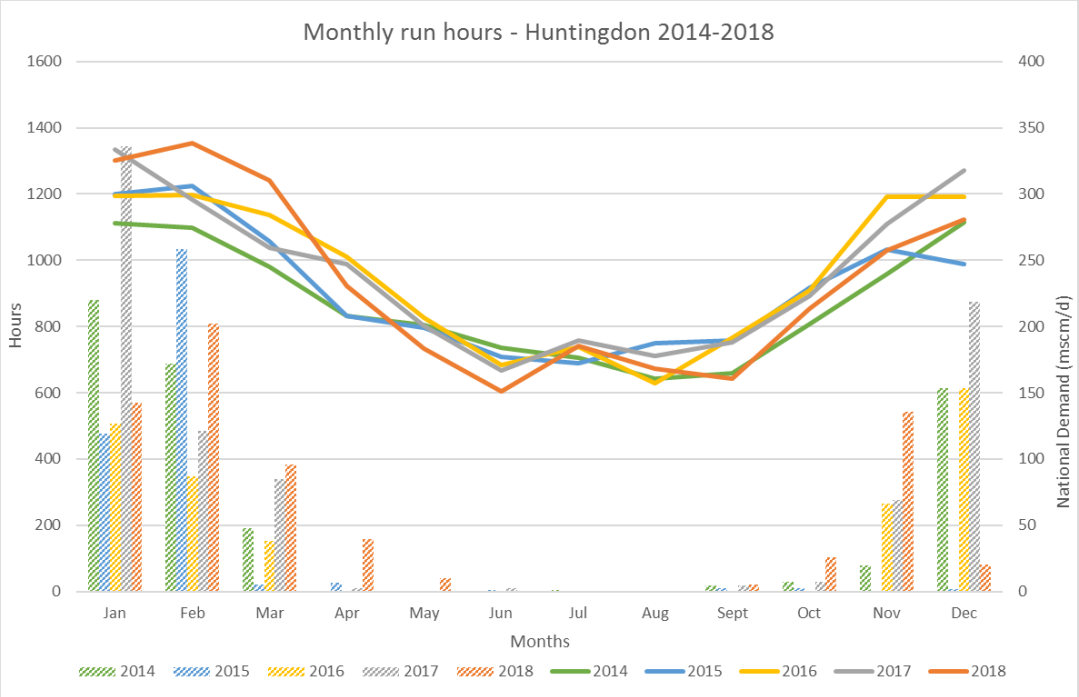

Figure 4: Monthly run hours against the average monthly National Demand level for Huntingdon compressor station (2014-2018)

5.9 When the Peterborough site is in operation, the required flow through the site means parallel operation is required most of the time. **Figure 5** shows the percentage of time that parallel operation is essential.

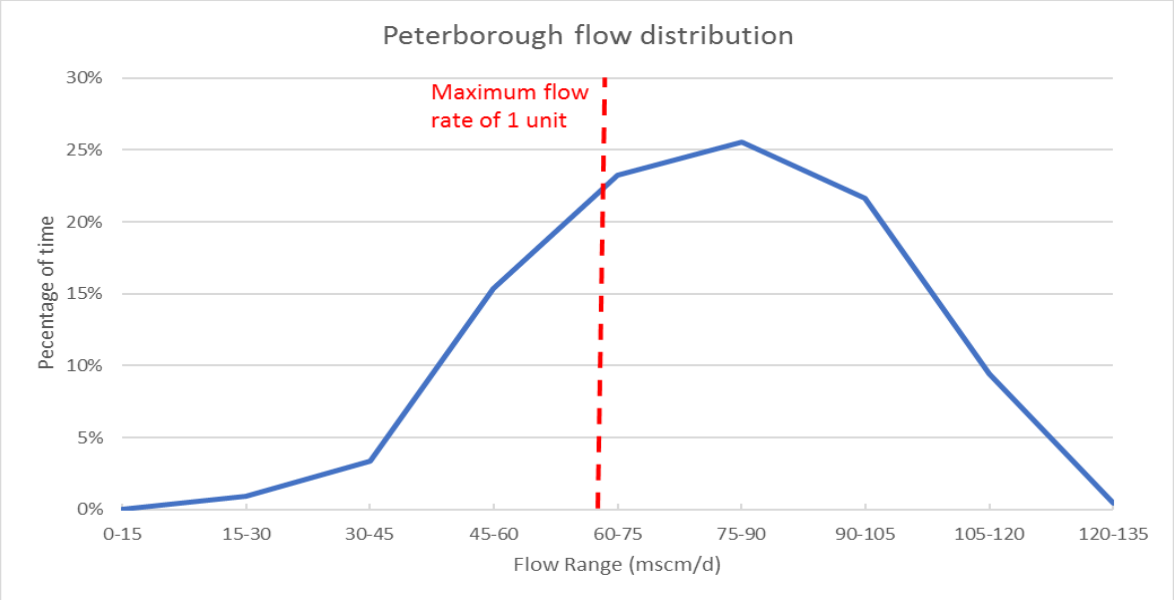

Figure 5: Peterborough flow distribution

5.10 **Figure 6** shows that once national demand is above 250 mscm/d, parallel operation at Peterborough is essential for most of the time the site is operated.

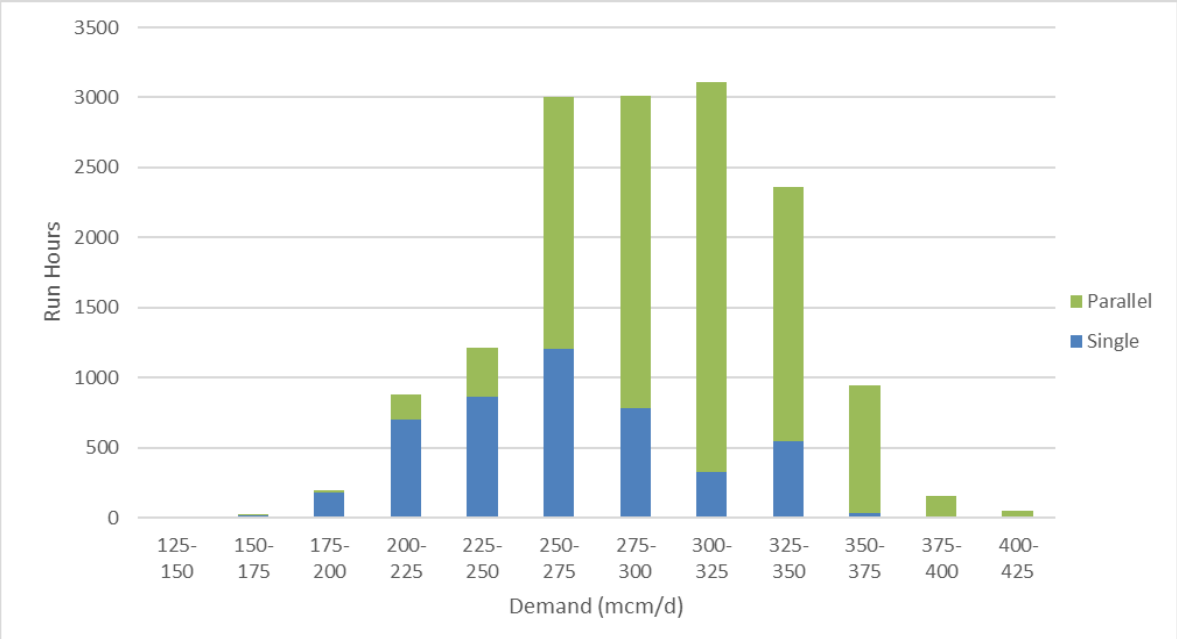

Figure 6: Compressor run hours at Peterborough compared to national demand (1 January 2014 – 31 December 2018)

5.11 When the Huntingdon site is in operation the flow through the site means that parallel operation is often required at the same time as Peterborough. **Figure 7** shows the percentage of time that flows are above the flow limit of one unit and parallel operation is essential.

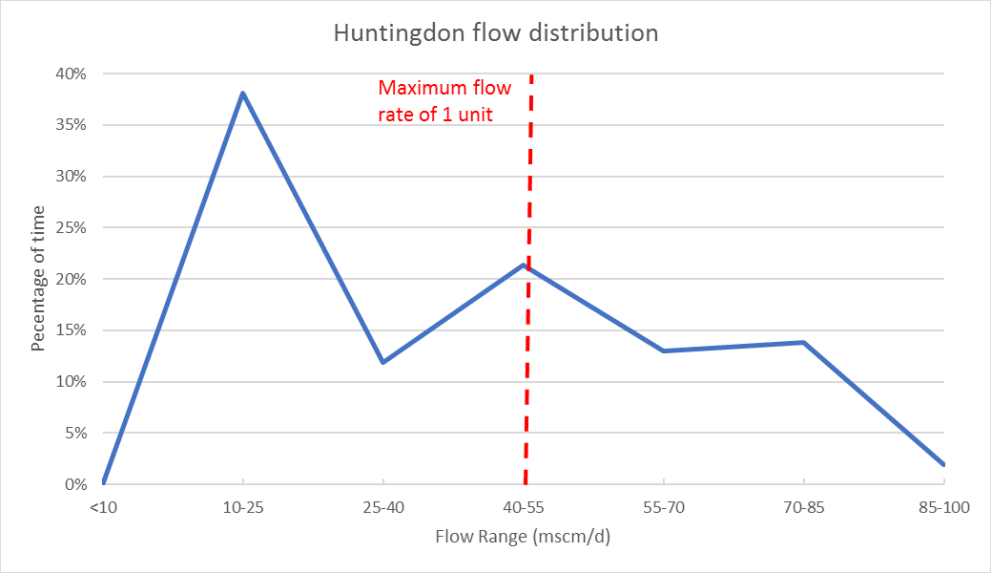

Figure 7: Huntingdon flow distribution

5.12 **Figure 8** shows that as the national demand increases there is an increase in the requirement for Huntingdon parallel operation and that a high proportion of the total run hours is for parallel operation.

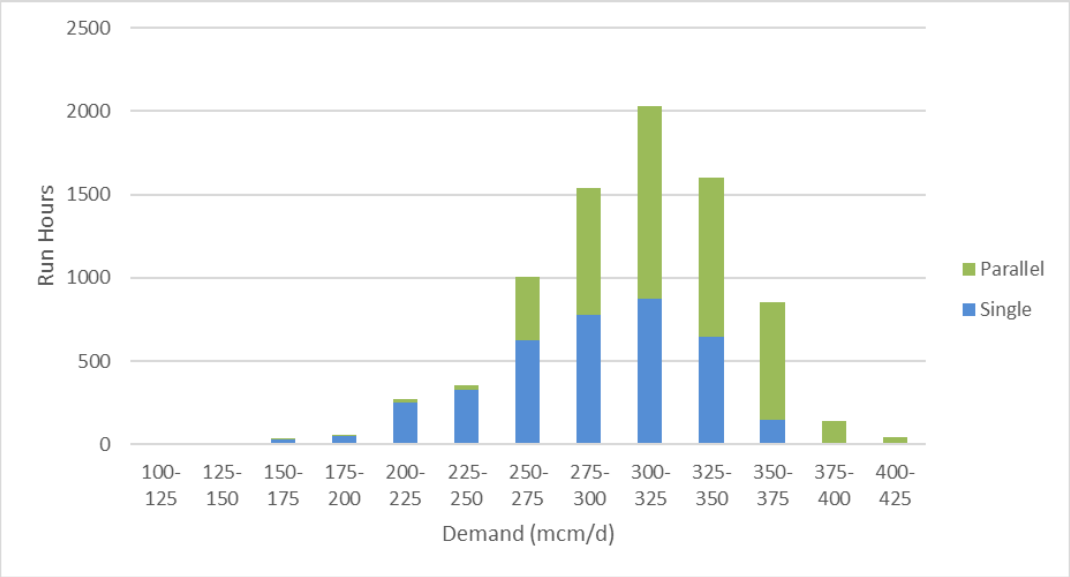

Figure 8: Compressor run hours at Huntingdon compared to national demand (1 January 2014 – 31 December 2018)

Future compression requirements

5.13 The need for parallel operation is the primary driver for a third resilient unit to provide the necessary capability. To fully assess the project and the future impact of the MCPD at Peterborough and Huntingdon, a network assessment was made to determine constraint risks and the future parallel operation requirements. The network assessment was done to define capability boundaries for the Southern Exit points.

5.14 **Figure 9** to **Figure 12** to show the risk of constraints under different asset availability assumptions. Each dot on the chart is associated with one day in that year and for every day there is 1000 alternative supply and demand patterns. The different coloured dots are for different years showing how we expect supply and demand

patterns to change over time. The table at the top of the chart shows how the number of dots above a line translates into constraint days.

5.15 **Figure 9** shows how the capability of the network is reduced from the intact network, the orange line when all compressors are in operation, to the green no compression line, when compression at Peterborough, Huntingdon, Aylesbury, Lockerley, Cambridge, Diss and Chelmsford are all assumed to be unavailable (the green line). It shows how at low demand levels (<200 mscm) no compression is required, on the basis that southern supply meets southern demand and how southern demand in the Steady Progression scenario is reducing; however, to fully cover the capability requirements, compression at Peterborough and Huntingdon is required. It also shows the National Demand is reducing but with a significant number of days above a 250 mscm/d demand that would require parallel operation at Peterborough and Huntingdon.

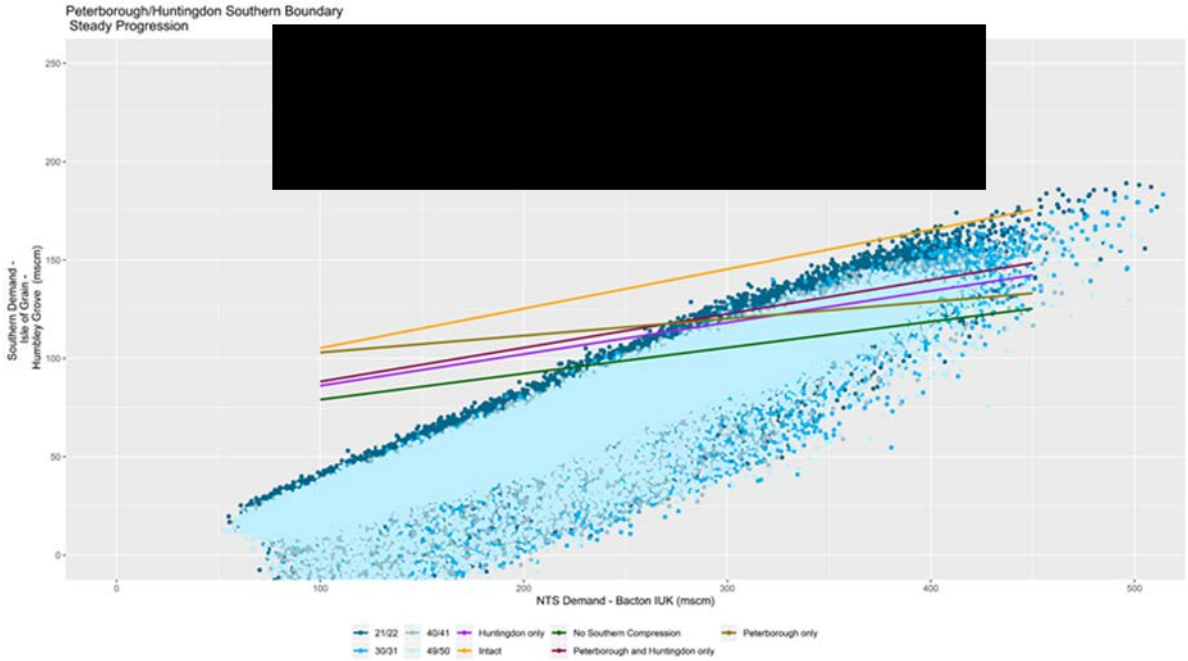

Figure 9: Southern exit capability (Steady Progression 2018)

5.16 Steady Progression is the central case of the four scenarios based on the assumption of the likely future. However, of the four scenarios it is the high constraint outcome **Figure 10** shows the Consumer Evolution scenario. This shows the southern demand reducing at a faster rate with either compression at Peterborough or Huntingdon being sufficient to remove the risk of constraints after 2040/41. However, even in this scenario there are still a number of days above 250 mscm/d requiring parallel operation to avoid constraints.

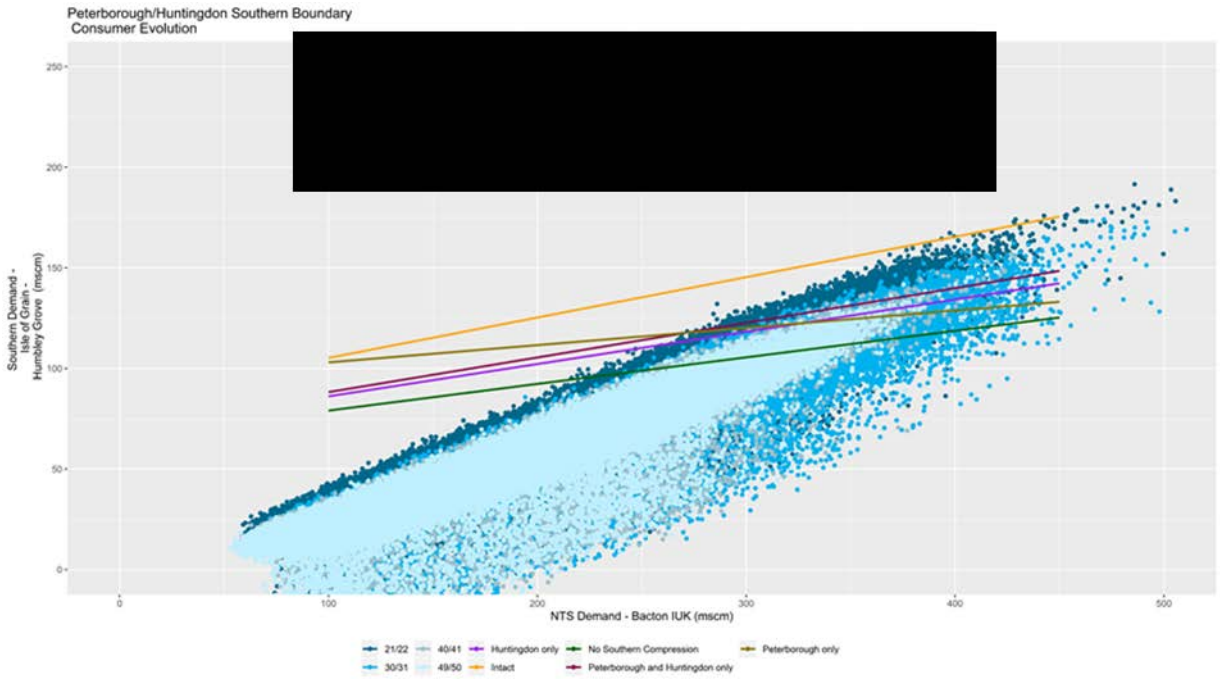

Figure 10: Southern exit capability (Consumer Evolution 2018)

5.17 **Figure 11** and **Figure 12** show the low cases for the Community Renewables and Two Degrees scenarios. In both these scenarios there is a large drop off in demand and from the 2030's there would be no need for compression south of Peterborough, assuming southern supplies fully meet southern demand. These scenarios show that from 2040 the requirement for parallel operation will have reduced.

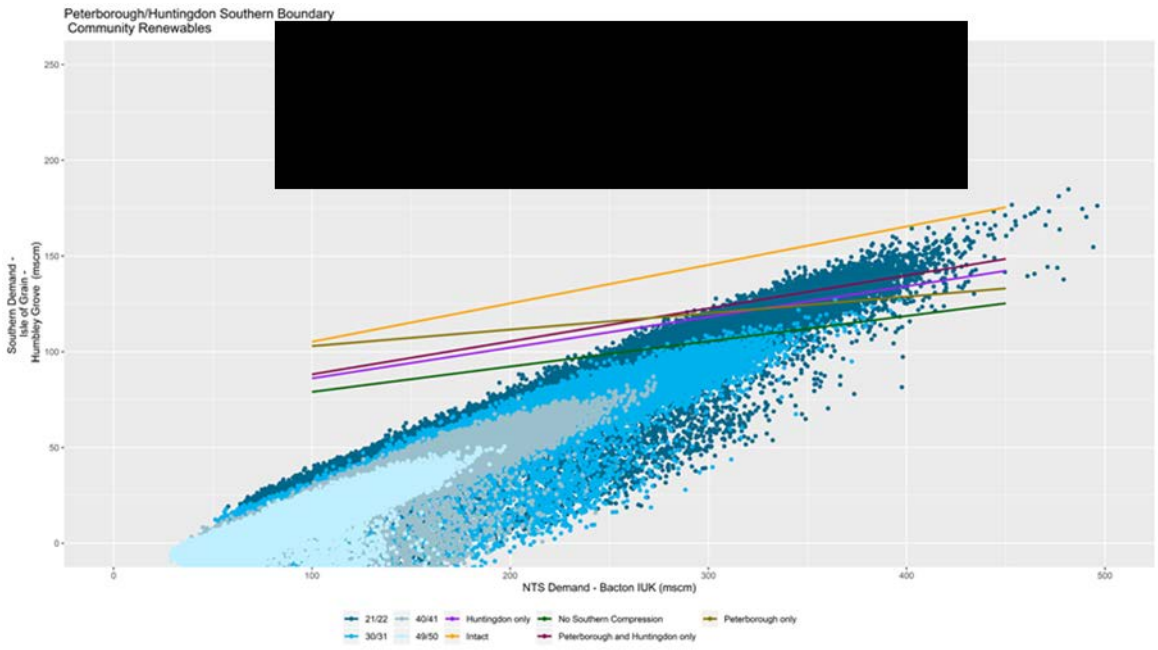

Figure 11: Southern exit capability (Community Renewables 2018)

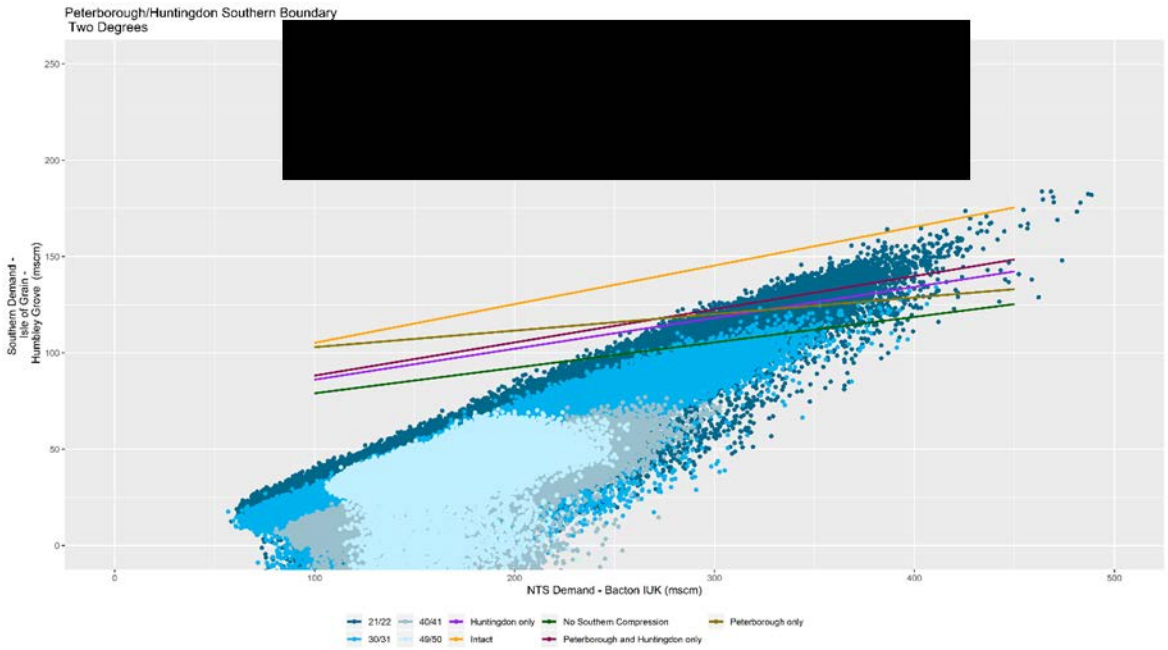

Figure 12: Southern exit capability (Two Degrees 2018)

5.18 Another key requirement for the compressors at Peterborough and Huntingdon is ensuring the network can meet the 1-in-20 design standard. **Figure 13** shows that in central case Steady Progression compression will be required at both Peterborough and Huntingdon beyond 2050. There will also be a requirement for other sites in the South West and East to fully cover the obligation in this scenario.

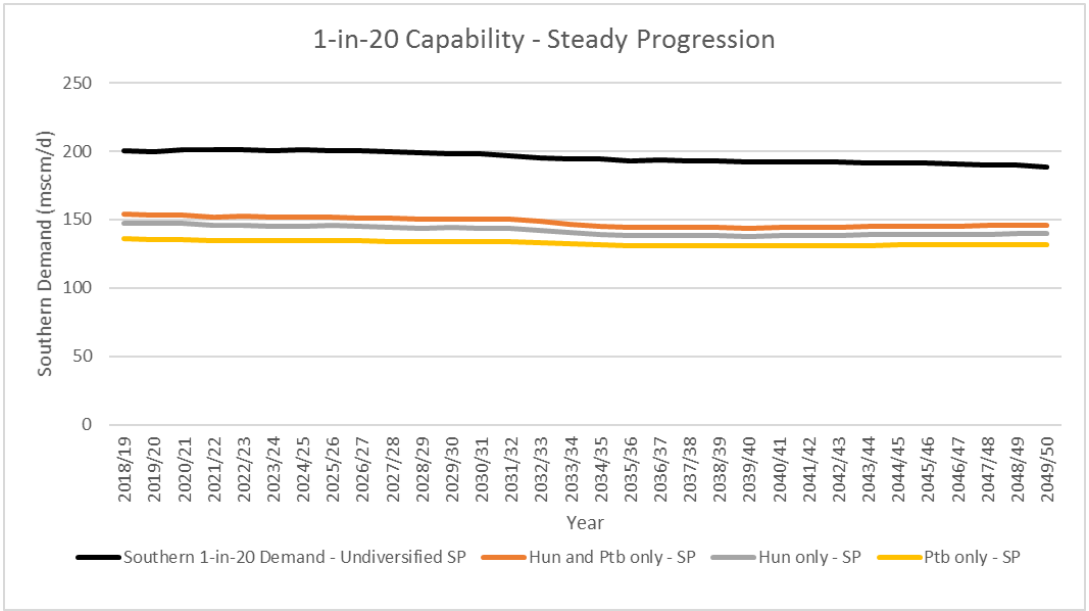

Figure 13: 1-in-20 Network Capability - Steady Progression

5.19 **Figure 14** shows the Two Degrees scenario, with it being possible to cover the 1-in-20 design standard with either Peterborough or Huntingdon after 2042. After 2044 no compression is required to support exit demand in the South, assuming southern supply is sufficient.

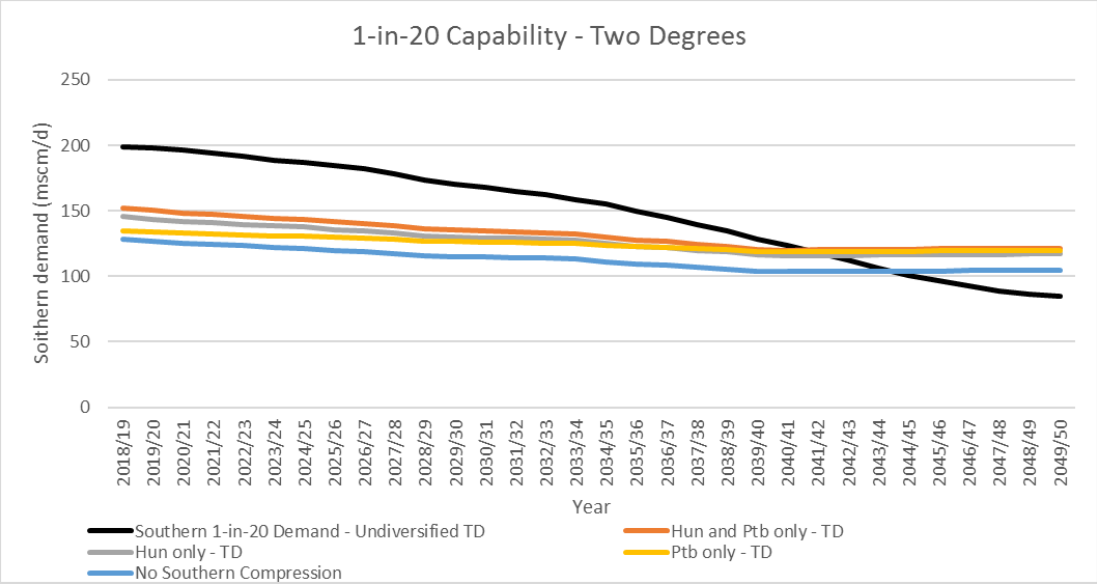

Figure 14: 1-in-20 Capability - Two Degrees

5.20 Assuming sufficient compression at Huntingdon, Diss, Chelmsford, Cambridge, Aylesbury and Lockerley are fully available there was no significant constraint risk with parallel operation at Peterborough or Huntingdon not available. However, without either Peterborough or Huntingdon available, all of those compressors are likely to be required. By ensuring suitable levels of compression are available at Peterborough and Huntingdon it is possible to place derogations on the non-compliant MCPD units at Diss, Chelmsford and Cambridge as well as limit any future investment.

Forecast Running Hours

5.21 We have compiled forecasts of running hours, shown in **Figure 15** and **Figure 16**, based on the scenarios described in the preceding sections. While overall running of the stations decreases in line with demands, the requirement for Avon running remains at around 500 hours/year (the derogation limit) from 2030 for the remainder of the period.

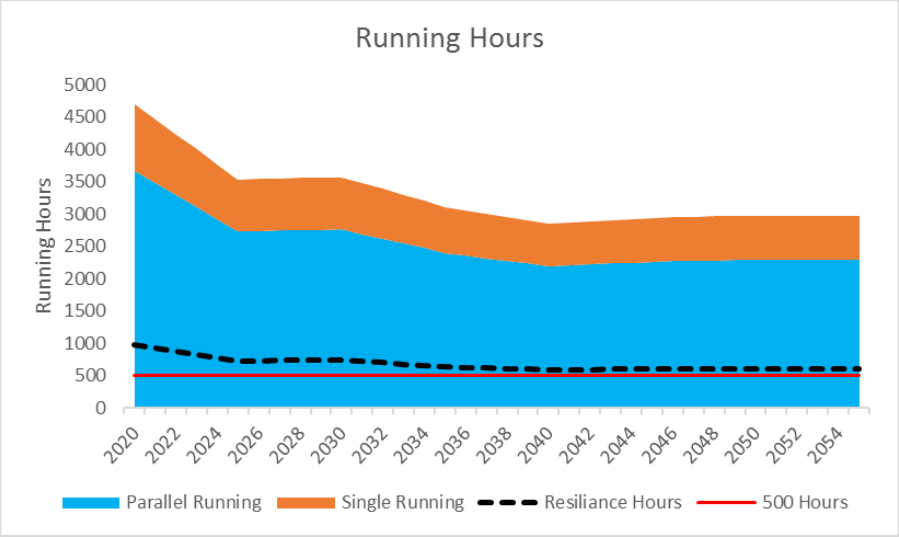

Figure 15: Peterborough Station Forecast Running Hours

5.22 This level of running is likely to restrict the operation of Peterborough in options where only a single derogated Avon is present from 2030. This would likely result in constraints along with a greater reliance on other compressor stations. At Huntingdon, we do not expect the 500-hour derogation to impact running (hence our proposed approach).

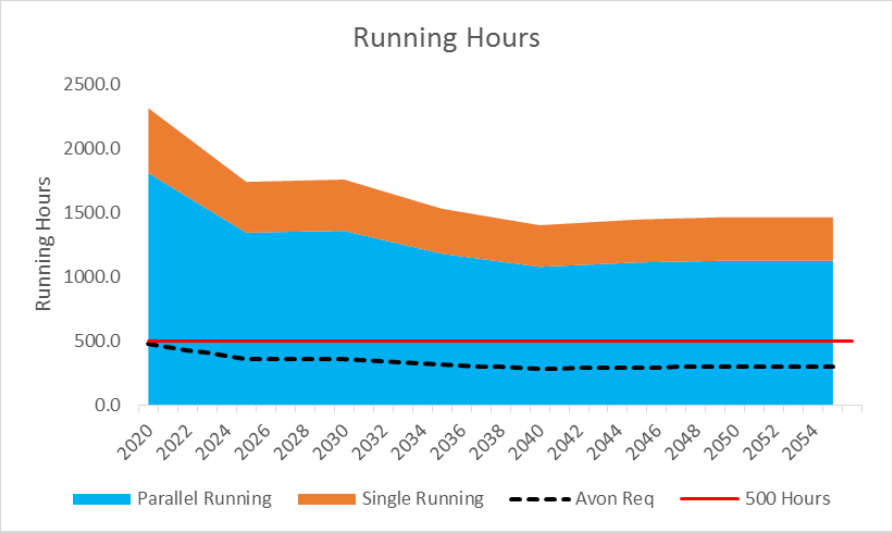

Figure 16: Huntingdon Station Forecast Running Hours

Compressor Availability

5.23 We calculate compressor availability based on historical averages for each compressor type on the network – this is highlighted in **Table *26*** This calculation uses the number of trips per 1,000 hours in the last five years. We then estimate the expected outage duration for each trip based on our operational experience, giving the availabilities shown in **Table 6**.

Table 6: Compressor Availability

Unit	500 hr	>500 hrs
AVON 1533	85%	73%
Solar Titan	94%	86%
New 15MW gas unit	97%	88%

Project Scope Summary

5.24 Our recommendation is to construct one new unit and decommission three at Peterborough to give an appropriate level of availability at the site while maintaining the principle of more reliable, medium-sized units. Our recommendation is to decommission two units and derogate one unit at Huntingdon. **Table 7** provides the project scope summary.

Table 7: Peterborough and Huntingdon Project Scope Summaries

	New build at Peterborough	**Decommissioning at Huntingdon**
Location	Peterborough Compressor Station	Huntingdon Compressor Station
Number of units	One medium sized unit	N/A
Size of units	Medium – circa 15MW	N/A
Type of unit	Gas Turbine (GT)	N/A
Scope boundaries	The scope of this project is for costs associated with the implementation of the MCPD only. For Peterborough, these are costs associated with building 1 x new GT unit and decommissioning of 3x existing GT units.	The scope of this project is for costs associated with the implementation of the MCPD only. For Huntingdon, these are costs associated with decommissioning 2 x existing GT units.
Station design Discharge pressure	70 barg	75 barg
Station suction trip pressure	37.9 barg	39 barg
Availability required	The optimum level of availability is determined by the selected option.	The optimum level of availability is determined by the selected option.

6. Options Considered

Option Summary

6.1 The options we considered cover a range of commercial, regulatory and physical solutions to provide capability for all compressor units captured by MCPD. These options are laid out within CECS. In all cases the counterfactual is to retain all non-compliant units which would be limited to 500 hours (derogated) from 1 January 2030.

6.2 Where new build options are assessed, at this stage (pre-FEED) we assume these will be built on adjacent unused land, within National Grid boundaries where existing sites cannot be guaranteed as suitable. An independent Geographical Information Systems (GIS) screening exercise will be undertaken, as part of FEED to identify potential parcels of land for new MCPD-compliant compressor units considering constraints imposed by separation and safety distances, buried feeders and key infrastructure, HSE consultation distances to sensitive neighbourhood receptors and other environmental and statutory constraints. Further consideration will be given to, amongst other things, preliminary engineering review and appraisal and initial environmental constraints surveys. Options are based on two new IPPC units installed at Peterborough and Huntingdon sites by 2021.

6.3 A high-level summary of all options considered for Peterborough and Huntingdon is shown in **Table *8***. SCR emissions reduction technologies cannot be considered a viable option at this stage. The compression requirement at does not lend itself to retro fit reduction measures as it is a substandard reduction, compared to new units, to already aged asset base.

Table 8: Full Options List

Standard options for Avon	Assessed	In which Option and on which compressor units Or Why option wasn't considered	
		Peterborough	Huntingdon
500 hours Derogation (counterfactual)	✓	Option 0 (units ABC); Option 1 (units BC); Option 2 (unit C)	Option 0 (units ABC); Option 1 (units BC); Option 2 (unit C)
Two new 15MW Gas Turbine Compressors, decommission Avon once new unit is operational.	x	Only one unit is within scope	Only one unit is within scope
Control system restricted performance*	x	A study is underway to access the viability of this option at other sites with lower anticipated running hours as an alternative to derogation. If this option proves feasible, it may be considered to this site also.	A study is underway to assess the viability of this option at sites including Huntingdon as an alternative to derogation. This option will be assessed further during FEED.
One new 15MW Gas Turbine Compressor, decommission Avon once new unit is operational.	✓	Option 3	Option 3
One new 30MW Gas Turbine Compressor, decommission Avon once new unit is operational.	x	A 15MW solution is sufficient to work in conjunction with the IPPC units D and E.	A 15MW solution is sufficient to work in conjunction with the IPPC units D and E.
Emissions abatement (Selective Catalytic Reduction (SCR)) on Avon	x	Selective Catalytic Reduction (SCR) emissions reduction technologies cannot be considered a viable option. This is because they would not be able to achieve the BAT efficiency levels of new machines at 36.5%. This in combination with the compression requirement does not lend itself to retro fit reduction measures as it is a substandard reduction, compared to new units, to already aged asset base.	
Disconnect and Decommission Avon prior to 2030*	✓	Option 1 (unit A); Option 2 (units AB); Option 3 (units ABC);	Option 1 (unit A); Option 2 (units AB); Option 3 (units ABC);
Two new 15MW Electric Drive Compressors, decommission Avon once new unit is operational.	x	IPPC unit BAT assessment concluded that GT units where preferable to electric alternatives due to availability of a connection.	IPPC unit BAT assessment concluded that GT units where preferable to electric alternatives due to availability of a connection.
One new 30MW Electric Drive Compressor, decommission Avon once new unit is operational.	x		
Commercial contracts to manage constraints and to ensure compliance with 1-in-20 obligations	x	Not required to comply with 1-in-20 obligations as hours on derogated units would be preserved for 1-in-20 cover.	Not required to comply with 1-in-20 obligations as hours on derogated units would be preserved for 1-in-20 cover.

* Control System Restricted Performance is where an Avon operating at full power emits a NOx level close to the 150mg/m3 legislative limit, it may be possible to permanently de-rate the Avon to limit the power in the control system and reduce emissions from the unit Please see CECS Annex A16.05 for more information.

6.4 Costs have been compiled internally by eHub, National Grid's Estimating and Cost team and by our Compressor team. Compressors and decommissioning costs are based on previous project experience. National Grid operational expenditure (OPEX) and asset health, is calculated on a site-specific basis from historical data. The differences in asset health costs between Peterborough and Huntingdon are due to the different conditions of the assets at each site. We have assessed our costs used against Ofgem guidance and confirm the following view.

Cost realised from RIIO-1 actuals	Cost forecast based on competitive process or previous tenders	External Benchmarking	Proposed Price Control Deliverable mechanism
Yes	Yes	No	Yes

6.5 Constraints and contracting costs are calculated using the Steady Progression scenario of the FES 2018, with a low case sensitivity using Two Degrees and high case sensitivity using Consumer Evolution. There is no specific scenario focussed on achieving the net zero target. However, the expected gas usage outlined in the net zero sensitivity in FES 2019 fell between the gas usage of the Two Degrees and Community Renewables scenarios which are examined.

6.6 Cost estimates used in the CBA include a sensitivity range associated with P50.

6.7 We have developed a set of additional criteria to assess options alongside the CBA, which is summarised below in **Table 9**. The key considerations overview assumes there are four new IPPC units across the Peterborough and Huntingdon compressor sites. More information on how this is used can be found in the CECS.

Table 9: Option Criteria

Criteria	Description				
Can we meet FES predicted Entry levels?	Cannot meet FES Entry levels.	Meets FES Entry levels in less than 50% of the scenarios.	Meets FES Entry levels in 50% or more of the scenarios.	Meets FES Entry levels in all scenarios.	Increased Entry levels above predicted FES levels.
Can we meet FES predicted Exit levels?	Cannot meet FES Exit levels in all scenarios.	Meets FES Exit levels in less than 50% of the scenarios.	Meets FES Exit levels in 50% or more of the scenarios.	Meets FES Exit levels in all scenarios.	Increased Exit levels above predicted FES levels.
Does this option represent an appropriate level of resilience on the network?	Does not provide resilience for the loss of largest credible unit(s) at the station.	Reduces resilience considering the loss of units at interacting stations, where the affected units are currently next in line.	Reduces resilience for the loss of units at interacting stations, where the affected units are not currently first in line.	Provides similar level of resilience as the existing situation.	Increases the resilience of the network.
Does this option allow National Grid to retain current capability?	Will reduce capability and impact how the NTS is currently used.	Capability reduced to a level insufficient to meet sold capacity and/or FES levels.	Capability reduced to potentially be insufficient to meet sold capacity and/or FES levels.	Sufficient capability to meet sold capacity and/or FES levels.	Increased capability to meet sold capacity and/or FES levels.
Does this option allow the network to be operated in sensitivities beyond FES?	FES cannot be met.	Significantly reduces capability to exceed FES.	Reduces capability to exceed FES.	Provides similar capability as the existing situation to exceed FES.	Enhances the ability over the existing situation to exceed FES.

Option Descriptions

6.8 Each option considered for Peterborough and Huntingdon to achieve compliance with MCPD, comprises asset actions, commercial actions, benefits, a summary and risks, where necessary.

6.9 The options considered are consistent for Peterborough and Huntingdon. We have then considered different combinations of these options in a single CBA assessment.

Option 0 - Counterfactual (500hr Derogation three units)

6.10 The counterfactual option is the option that minimises RIIO-2 and RIIO-3 investment in new build units or asset decommissioning whilst meeting compliance with legislation. This option removes the need for new MCPD driven asset investment and utilises the existing units.

Asset actions

6.11 The counterfactual option is to maintain existing Avon Units A, B and C until 31 December 2029 and place them on 500 hours' derogation from 1 January 2030.

Commercial actions

6.12 No commercial contracts were needed to comply with any National Grid requirements. Network constraints would be managed using existing tools. Costs are calculated as part of the economic assessment based on their frequency and size.

Benefits

6.13 This option delivers MCPD compliance with the minimum intervention, but with significant asset health investment. A high-level qualitative view of how the option measures up against the criteria is summarised in Table 10 and availabilities in Table 11.

Table 10: Counterfactual benefits

Can we meet FES predicted Entry levels?	Can we meet FES predicted Exit levels?	Does this option represent an appropriate level of resilience on the network?	Does this option allow National Grid to retain current capability?	Does this option allow the network to be operated in sensitivities beyond FES?

Table *11*: Counterfactual availability

Availability	Current	2023	2030
Two units	99.7%	99.7%	99.7%

Risks

6.14 The current Avon units are over 40 years old. The age of the assets means that there are asset condition and obsolescence issues that need to be addressed to ensure continued reliability, safety and environmental compliance at the station. This brings an increased maintenance burden, and higher probability of unavailability due to asset health concerns. Despite the significant re-life costs, there is the risk that such aged assets will no longer be supported by OEMs which would result in reliability concerns. Additionally, the 500-hour limitation increases the network risk if high running hours are required post 2029. Keeping all three Avon units would allow up to 1,500 running hours per year. While this reduces the operational risk of mitigating an unplanned outage on site, it would not be the optimal result reducing emissions. The approach would also mean a total of five units at the site, which goes against National Grid's strategy of fewer, more reliable units, and would increase the risk of unexpected outages and OPEX spend as the Avon units continue to age.

6.15 The cost breakdown of the option is given in Table 12.

Table 12: Counterfactual option cost

Title	Total Installed cost (£m)	Asset Health cost (£m)	Decommissioning cost (£m)	Cost accuracy
0 - Counterfactual 500 Hr x 3 (Peterborough)				P50
0 - Counterfactual 500 Hr x 3 (Huntingdon)				P50

Option 1 - 500hr Derogation two units, decommission one (2x 500hr, 1x Decommission)

6.16 This option retains two of the existing units on a derogated basis from 1 January 2030 and decommissions the third. This allows comparison of the asset health cost of maintaining the third unit with any additional constraint costs associated with reduced resilience at the site.

Asset actions

6.17 This option explores maintaining Avon units A and B until 31 December 2029 and placing them on 500 hours' derogation from 1 January 2030. In this option, Avon

Unit C would be maintained until the two new units (D and E) have been operationally accepted, following which it would be decommissioned.

Commercial actions

6.18 No commercial contracts were needed to comply with any National Grid requirements. Network constraints would be managed using existing tools. Costs are calculated as part of the economic assessment based on their frequency and size.

Benefits

6.19 This option delivers MCPD compliance and reduces ongoing asset health costs, but with reduced flexibility and ability to operate in sensitivities beyond FES 2018.

6.20 A high-level qualitative view of how the option measures up against the criteria is summarised in **Table 13** and availabilities in **Table 14**.

Table 13: Derogate 2 + Decom 1 benefits

Can we meet FES predicted Entry levels?	Can we meet FES predicted Exit levels?	Does this option represent an appropriate level of resilience on the network?	Does this option allow National Grid to retain current capability?	Does this option allow the network to be operated in sensitivities beyond FES?

Table 14: Derogate 2 + Decom 1 availability

Availability	Current	2023	2030
Two units	99.7%	99.7%	98.8%

Risks

6.21 The current Avon units are over 40 years old. This brings an increased maintenance burden, and higher probability of unavailability due to technical issues. Additionally, the 500-hour per annum per unit limitation increases the network risk if high running hours are required from 2030. The approach would also mean a total of 4 units at the site, which goes against the strategy of fewer, more reliable units, and would increase the risk of unexpected outages and OPEX spend as the Avon units continue to age.

6.22 The cost breakdown of the option is given in **Table 15**.

Table *15*: 2x 500hr, 1x Decommission costs

Title	Total Installed cost (£m)	Asset Health cost (£m)	Decommissioning cost (£m)	Cost accuracy
1 - 500 Hr Derogation x 2 (Peterborough)				P50
1 - 500 Hr Derogation x 2 (Huntingdon)				P50

Option 2 - 500hr Derogation one unit, decommission two (1x 500hr, 2x Decommission)

6.23 This option retains one of the existing units on a derogated basis from 1 January 2030 and decommissions the two remaining units. This allows comparison of the asset health cost of maintaining the second and third unit with any additional constraint costs associated with reduced resilience at the site.

Asset actions

6.24 This option explores maintaining Avon Unit C until 31 December 2029 and place it on 500 hours' derogation from 1 January 2030. In this option, Avon units A and B would be maintained until the two new units (D and E) have been operationally accepted, following which they would be decommissioned.

Commercial actions

6.25 No commercial contracts were needed to comply with any National Grid requirements. Network constraints would be managed using existing tools. Costs are calculated as part of the economic assessment based on their frequency and size.

Benefits

6.26 This option delivers MCPD compliance and reduces ongoing asset health costs, but with reduced flexibility and ability to operate in sensitivities beyond FES 2018.

6.27 A high-level qualitative view of how the option measures up against the criteria is summarised in **Table 16** and availabilities in **Table 17**.

Table *16*: Derogate 1 + Decom 2 benefits

Can we meet FES predicted Entry levels?	Can we meet FES predicted Exit levels?	Does this option represent an appropriate level of resilience on the network?	Does this option allow National Grid to retain current capability?	Does this option allow the network to be operated in sensitivities beyond FES?

Table *17*: Derogate 1 + Decom 2 availability

Availability	Current	2023	2030 - Ptb	2030 - Hun
Two units	99.7%	99.7%	83.8%	91.8%

Risks

6.28 Though there would be three units available (currently three) there would be a decrease in network resilience as one of the three units would be limited on run hours. The current Avon units are over 40 years old. This brings an increased maintenance burden, and higher probability of unavailability due to technical issues. Additionally, hours are required from 2030. This goes against National Grid's strategy of fewer, more reliable units, and would increase the risk of unexpected outages and OPEX spend as the Avon units continue to age.

6.29 The cost breakdown of the option is given in Table 18.

Table 18: 1x 500hr, 2x Decommission option cost

Title	Total Installed cost (£m)	Asset Health cost (£m)	Decommissioning cost (£m)	Cost accuracy
2 - 500 Hr Derogation x 1 (Peterborough)				P50
2 - 500 Hr Derogation x 1 (Huntingdon)				P50

Option 3 - One new Gas Turbine (GT) Compressor (One new unit)

6.30 This option installs one new unit of an equivalent size to the new units already being delivered for IPPC and decommissions the three existing units. This allows comparison of the investment cost of installing a new unit with the reduction in constraint costs associated with increased resilience at the site.

Asset actions

6.31 One new MCP compressor would be built, by 2029, and following its operational proving retained Avon Unit C would be decommissioned. In this option, Avon units A and B would be retained until new IPPC units D and E had been operationally proven after which units A and B would be decommissioned, as per plan.

Commercial actions

6.32 No commercial contracts were needed to comply with any National Grid requirements. Network constraints would be managed using existing tools. Costs are calculated as part of the economic assessment based on their frequency and size.

Benefits

6.33 Being high utilisation site Huntingdon regularly sees high run hours. This option maintains the principle of a smaller number of more reliable units.

6.34 A high-level qualitative view of how the option measures up against the criteria is summarised in **Table 19** and availabilities in **Table 20**.

Table *19*: 1 New + Decom 3 benefits

Can we meet FES predicted Entry levels?	Can we meet FES predicted Exit levels?	Does this option represent an appropriate level of resilience on the network?	Does this option allow National Grid to retain current capability?	Does this option allow the network to be operated in sensitivities beyond FES?

Table *20*: 1 New + Decom 3 availability

Availability	Current	2023	2030
Two units	99.7%	99.7%	93.0%

Risks

6.35 This option requires significant CAPEX, and up to a 7-year build period. There is also the risk of unused assets if gas volumes are insufficient to need the new MCPD driven compressor.

6.36 The cost breakdown of the option is given in *Table 21*.

Table *21*: One new unit option cost

Title	Total Installed cost (£m)	Asset Health cost (£m)	Decommissioning cost (£m)	Cost accuracy
3 - One New Gas Turbine (Peterborough)				P50
3 - One New Gas Turbine (Huntingdon)				P50

Options Cost Estimate Details

6.44 The costs used in this analysis have been sourced and reviewed through eHub. They are appropriate at this stage with a view of updating them once Preliminary BAT is complete. The cost estimate for the preferred option (build one new unit) is summarised in **Table 22**.

Table *22*: Cost Estimate Details

MCP 1 x 15MW (1 x GT unit)				
Item	**Ofgem Guidance Note**	**National Grid Notes**	**Cost (£m)**	**% of Total Installed Cost**
Engineering Design	Detail costs for Studies/FEED/Detailed Design as appropriate.	Feasibility Studies and FEED works. Detailed Design (by Main Works Contractor).		
Project Management	Element of Project Costs attributed to Project Management, not direct or indirect company costs.	Main Works Contractor Project Management.		
Materials	Bulk Materials, breakdown preferred.	Supplied by Main Works Contractor. (Included within 'Main Works Contractor' item cost).		

Main Works Contractor	Project Construction Contractor costs.	Main Works Contractor to carry out Detailed Design, Supply of Balance of Plant, Construction and Commissioning. Detailed Design cost shown in 'Engineering Design' item cost.	[redacted]
Specialist Services	Costs for any additional services used to support the project i.e. surveys, data procurement etc.	Land and Easements.	
Vendor Package Costs	Costs of packages purchased for project.	Compressor Machinery Train Detailed Design and Supply by Compressor OEM. Costs are taken from those received during tender event (evaluation ongoing at time of writing).	
Direct Company Costs	Refer to Regulatory Instructions and Guidance for definition of direct company costs.	National Grid Project Management based on 52 weeks Detailed Design and 104 weeks Construction/Commissioning durations.	
Indirect Company Costs	Refer to Regulatory Instructions and Guidance for definition of indirect company costs.	National Grid indirect costs (Costs of Function %).	
Contingency	Contingency included in base cost estimate.	Technical and Commercial contingency associated with Compressor OEM tender (evaluation ongoing at time of writing).	
		Main Works Contractor contingency.	
Total Installed Cost	Forecast total project cost including contingency. Sum of all elements noted above.		
Cost Estimate Accuracy	This is an important element to give confidence that the engineering is mature and the costs can be relied upon.	P50 Please see cost accuracy table overview in 6.4 and CECS in annex A16.05 for overview of option costs.	

Options Summary Breakdown

6.45 **Table 23** summarises how the options compare against the criteria described in **Table 9.**

Table *23*: Peterborough Options Summary

Options	***Can we meet FES predicted Entry levels?***	***Can we meet FES predicted Exit levels?***	***Does this option represent an appropriate level of resilience on the network?***	***Does this option allow National Grid to retain current capability?***	***Does this option allow the network to be operated in sensitivities beyond FES?***
Counterfactual 500 hours					
Derogate 2, decommission 1					
Derogate 1 + decommission 2					
One new + decom 3					

Key Considerations

Resilience

6.46 The installation of a new compressor or SCR of an existing Avon provides similar levels of resilience to those seen today. The level of resilience provided by the derogated units depends on the number of run hours required by each unit. Only having one derogated unit would not have sufficient run hours reducing current level of resilience. With the predicted reduction in National Demand in the FES 2018 two or more derogated units would provide similar levels of resilience as today.

Current Capability and Future Energy Scenarios Entry and Exit levels

6.47 All options retain current levels of capability with at least two units available to operate in parallel. However, if units are not available, capability would be reduced.

Flexibility and Sensitivities Beyond FES 2018

6.48 The options that limit run hours would restrict the overall flexibility of the system to cover planned and unplanned outages across the fleet of compressors. They also limit ability to support high national or southern demand sensitivity beyond the FES 2018.

Option Summary Breakdown

6.49 To achieve MCPD compliance by 2030 and taking into account compressor investment at other MCPD sites, any new build project at Peterborough would need to begin FEED no later than 2025.

6.50 **Table 24** provides a comparison between the individual asset options considered. The differences in asset health costs between Peterborough and Huntingdon are due to the different conditions of the assets at each site. Operating costs are not included as they are considered only in the combined Peterborough and Huntingdon cluster analysis. Please see Section 7 for more details.

Table *24*: Comparison of Options

Option Title	Project start date (Establish Portfolio)	Project commissioning date	Project Design life	Total CAPEX (Pete.) cost, including:	*Total CAPEX (Hunt.) cost, including:*	•Total Installed cost (£m) *	•Asset Health cost – Pete. (£m) *	•*Asset Health cost – Hunt (£m) **	•Decommissioning costs (similar at Pete. and Hunt.)	Cost Accuracy
0 - 500 Hr Derogation x 3	2019	N/A	25yrs							P50
1 - 500 Hr Derogation x 2	2019	2029	25yrs							P50
2 - 500 Hr Derogation x 1	2019	2029	25yrs							P50
3 - One new Gas Turbine	2019	2029	25yrs							P50

**costs to 2055, 25 years following implementation of MCPD in 2030*

Cost accuracy lifespan

6.51 For the recommended option (one new unit and decommission three units at Peterborough and derogate one unit and decommission two units at Huntingdon), at this current ND500 4.1 stage, the cost accuracy is a P50 estimate. The cost accuracy

is expected to narrow further as the project progresses through the latter stages of the ND500, including FEED. Our cost proposal of [redacted] for one new unit at Peterborough is based on the assumptions in Section 8.6.

Preliminary BAT

6.52 Preliminary BAT analysis will be undertaken to input into FEED to support our CBA and to feed into the decision-making process.

7. Business Case Outline and Discussion

7.1 This section shows the breakdown of operational costs for each option. These costs along with the others detailed in the section are included in the CBA to produce a Net Present Value (NPV) for each option.

7.2 As the impact of changing the capability at Peterborough is linked to the capability at Huntingdon, these have been assessed as a single cluster in the CBA. This allows us to assess the impact that changing the capability at one site could have on the other. To do this we have looked at 16 combined options, summarised in **Table 25**, to assess the differing levels of capability at each site.

7.3 For the purposes of this assessment we have not assessed SCR at either site in the cluster analysis as it is unlikely to be a viable option. This option has not been ruled out at this stage. **Table 25** shows how the short list of options (linked to **Table *1*** and **Table 24**) map to the long list used for the CBA. For example, our chosen Option 6 is made up of Option 2 for Huntingdon and Option 3 for Peterborough.

Table *25*: Combined options for Peterborough and Huntingdon

Option	Short Name	Huntingdon Option	Peterborough Option
0	0 - Hun/Ptb 3 on 500	0 – 3 * 500 hours	0 – 3 * 500 hours
1	1 - Hun/Ptb 2 on 500	1 – 2 * 500 hours	1 – 2 * 500 hours
2	2 - Hun/Ptb 1 on 500	2 – 1 * 500 hours	2 – 1 * 500 hours
3	3 - Hun/Ptb 1 New	3 – 1 new 15MW unit	3 – 1 new 15MW unit
4	4 - Hun 3*500/Ptb New	0 – 3 * 500 hours	3 – 1 new 15MW unit
5	5 - Hun 2*500/Ptb New	1 – 2 * 500 hours	3 – 1 new 15MW unit
6	6 - Hun 1*500/Ptb New	2 – 1 * 500 hours	3 – 1 new 15MW unit
7	7 - Hun New/Ptb 3*500	3 – 1 new 15MW unit	0 – 3 * 500 hours
8	8 - Hun New/Ptb 2*500	3 – 1 new 15MW unit	1 – 2 * 500 hours
9	9 - Hun New/Ptb 1*500	3 – 1 new 15MW unit	2 – 1 * 500 hours
10	10 - Hun 3*500/Ptb 2*500	0 – 3 * 500 hours	1 – 2 * 500 hours
11	11 - Hun 3*500/Ptb 1*500	0 – 3 * 500 hours	2 – 1 * 500 hours
12	12 - Hun 2*500/Ptb 3*500	1 – 2 * 500 hours	0 – 3 * 500 hours
13	13 - Hun 2*500/Ptb 1*500	1 – 2 * 500 hours	2 – 1 * 500 hours
14	14 - Hun 1*500/Ptb 3*500	2 – 1 * 500 hours	0 – 3 * 500 hours
15	15 - Hun 1*500/Ptb 2*500	2 – 1 * 500 hours	1 – 2 * 500 hours

Key Business Case Drivers Description

Constraints

7.4 There is currently a small constraint risk which increases around 2030 before declining thereafter. This is shown in **Figure 17**. The constraint risk is mitigated both by declining demands and the availability of the lead units at both sites. The highest constraints occur in the options where the operation of Peterborough is limited by the 500-hour restrictions to the Avon units, these are options 2, 11 and 13, all of which only have a single Avon at Peterborough.

Figure 17: Annual constraint costs

Cost Breakdown

7.5 **Figure 18** and **Figure 19** show the breakdown of the costs in the CBA. This is split into the investment costs for compressors; the constraint costs; and compressor running costs. This allows a comparison over the relative costs for each option.

Figure 18: Asset Costs included in CBA

Figure 19: Constraints Costs included in CBA

Operating Costs

7.6 These cover all operational activities on site as shown in **Figure *20***.

Figure 20: Operating Costs included in CBA

7.7 While fuel costs are significant they are similar across all options and therefore are not a key factor in the overall decision, these can be seen in **Figure 20**. The option with the lowest fuel costs is, as expected, 3 – One new unit at both Huntingdon and Peterborough. The options with new units will show some fuel savings but as most of the duty in all options is taken by the existing DLE units at both sites these are not significant.

Environmental Benefits

7.8 Replacing the Avons with a new, cleaner unit reduces emissions. Compared to 0-Counterfactual, the recommended option 6 - 1 new unit at Peterborough, 1 derogated unit at Huntingdon - would reduce NOx emissions by 148 tonnes from 2030 – 2055. Further savings are possible in option 3 – New unit at both sites - which reduces NOx by 220 tonnes below the counterfactual as shown in **Figure 21**.

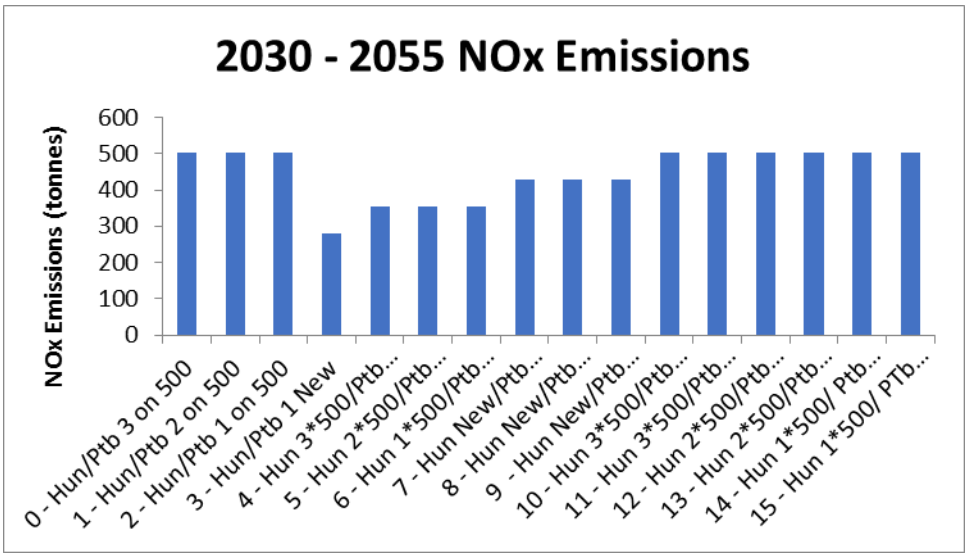

Figure 21: NOx Emissions

Sensitivities and Key Assumptions

7.9 We have applied three sensitivities to test Huntingdon/Peterborough against all four FES 2018 scenarios. Since the proposals are based on the FES 2018 there is no specific scenario focussed on achieving the net zero target. However, the expected gas usage outlined in the net zero sensitivity in FES 2019 fell between the gas usage of the Two Degrees and Community Renewables scenarios which are examined here.

7.10 As the constraint risk is relatively low across all four scenarios, dependent on the compression configuration, there is a limited impact on the CBA. The supply and demands, along with the capability boundaries can be seen in **Figure 9**,**Figure 10**,**Figure 11** and **Figure 12.**

7.11 The Two Degrees and Community Renewables have the lowest constraint risk. In both scenarios, seasonal gas demand declines significantly as both electricity and hydrogen are increasingly used for domestic heating.

7.12 The Consumer Evolution and Steady Progression scenarios have a greater constraint risk, as seasonal demands decline more slowly.

7.13 The supply/demand patterns are the key factor in the Peterborough/Huntingdon case Flexing our assumptions on compressor availability or constraint resolution did not impact the results of the CBA for this case. The key assumptions and sensitivities behind the Peterborough and Huntingdon case are detailed in **Table *26*** below.

Table 26: Key Assumptions and Sensitivities

Category	Assumption	Base Assumption	Rationale	Sensitivities Considered	Sensitivity Outcome
CBA parameters	WACC	2.9%	Defined in RIIO-2	N/A	
	Social Time Preference Rate	3.5% (Years 0 – 30) / 3.0 % (30+)	Defined in Green Book	N/A	
	Regulated Asset Life	45 years	Defined in RIIO-2	N/A	
	Assessment Period	25 years	Based on lifetime of asset	N/A	
	Depreciation	Straight Line	Defined in RIIO-2	N/A	
	Capitalisation	73.5%	Defined in RIIO-2	N/A	
Supply/Demand	Supply/Demand Scenario	Steady Progression (2018 FES)	Central case for utilisation of Peterborough and Huntingdon	Two Degrees (Low Case), Community Renewables (Low Case), Consumer Evolution (High Case),	Preferred option unchanged in Two Degrees, Community Renewables and Consumer Evolution
Investment Costs	Investment Costs	Option specific, see table 31 (P50)	Compiled by eHub and Compressor Team incorporating previous project experience	+/- 30% (Monte Carlo)	Other options not within range of Monte Carlo uncertainty
	Timing of Investment	FEED beginning April 2021 leading to Operational Acceptance in March 2027	Advanced delivery to facilitate outages for subsequent works at additional affected sites	N/A	
	Asset Health Costs	Option specific, see table 27 (P50)	Site-specific basis from historic data	+/- 30% (Monte Carlo)	Other options not within range of Monte Carlo uncertainty
Operating Costs	Site Operating Costs	Option specific, see table 27 (P50)	Site-specific basis from historic data	+/- 30% (Monte Carlo)	Other options not within range of Monte Carlo uncertainty
	Compressor Fuel Costs	Annual price 48 – 63p/th	BEIS reference scenario	N/A	
	Compressor Availability	Unit specific, see table 7 (LINK)	Based on observed running trips and expected return to service times	N/A	
	Constraint management volume	Specific to capability level	Output of network capability analysis	+/- 1 Standard Deviation (Monte Carlo)	Other options not within range of Monte Carlo uncertainty
	Constraint management pricing	As defined by Commercial Constraint Price Methodology	BEIS reference scenario	N/A	
	Constraint management method	50% buy-backs/50% locational actions	Reflective of tools available to manage constraints	25% buy-backs/75% locational actions	No change
Emissions	CO2 volume	Unit specific emission factors	Based on observed performance	N/A	
	CO2 cost	Annual price 12.8 – 42.7 £/tonne	BEIS reference scenario	N/A	
	NOx volume	Unit specific emission factors	Based on observed performance	N/A	
	NOx price	£6,199 £/tonne	DEFRA damage costs	N/A	

Business Case Summary

CBA Assessment

7.14 The NPVs based on our Central Scenario are shown in **Table 27**. The most positive NPV is option 2 – Hun/Ptb 1 x 500-hour unit (retain one existing unit on each site with a 500 hour derogation) with a positive NPV of £37.5m compared to the counterfactual[2]. Other options where the number of Avons are reduced, without installing new units, also have a positive NPV. Option 6 – Hun 1x500 hours (derogate one unit) /New unit Peterborough is the next most favourable with an NPV of £0.2m when compared to the counterfactual, this is favoured over options with a new unit at Huntingdon due to slightly more constraints and more running at Peterborough compared to Huntingdon. The recommended option at this stage is to proceed to FEED with option 6 as it provides the required resilience at one of the highest duty sites on the network, and ensures we are able to meet demands.

Table *27*: CBA Summary[3]

Short Name	NPV £m	Relative NPV £m
0 - Hun/Ptb 3 on 500	-£187.3 m	
1 - Hun/Ptb 2 on 500	-£167.1 m	£20.2 m
2 - Hun/Ptb 1 on 500	-£149.7 m	£37.5 m
3 - Hun/Ptb 1 New	-£234.3 m	-£46.9 m
4 - Hun 3*500/Ptb New	-£207.7 m	-£20.4 m
5 - Hun 2*500/Ptb New	-£196.1 m	-£8.8 m
6 - Hun 1*500/Ptb New	-£187.0 m	£0.2 m
7 - Hun New/Ptb 3*500	-£213.8 m	-£26.7 m
8 - Hun New/Ptb 2*500	-£205.3 m	-£17.9 m
9 - Hun New/Ptb 1*500	-£197.0 m	-£10.1 m
10 - Hun 3*500/Ptb 2*500	-£178.6 m	£8.7 m
11 - Hun 3*500/Ptb 1*500	-£170.1 m	£17.3 m
12 - Hun 2*500/Ptb 3*500	-£175.6 m	£11.5 m
13 - Hun 2*500/Ptb 1*500	-£158.5 m	£28.7 m
14 - Hun 1*500/ Ptb 3*500	-£166.4 m	£20.9 m
15 - Hun 1*500/ Ptb 2*500	-£157.9 m	£29.5 m

7.15 There will be a slight difference between the NPVs displayed in the justification papers and those in the Ofgem CBA template. The justification papers are based on our internal CBA model which uses Monte Carlo analysis to allow us to show the

[2] Note that these calculated NPVs assume a capitalisation rate of 73.5% as set out in CECS (Annex A16.05). This capitalisation rate has now been updated, and therefore there may be a minor mismatch between quoted NPVs between this document and the associated CBA (Annex A16.11). Please note that this does not affect the final proposed option. The impact of the updated capitalisation rate is reflected in the CBA document.
[3] See footnote 3

range of NPVs arising from the uncertainties in the cost, constraints and contracts. When the source data is entered into the Ofgem CBA template the predicted P50 of each element is used, this can be slightly different to the actual P50 of the simulation data. These differences only alter the overall NPV marginally and would not be sufficient to change the outcome of the CBA. The quoted NPV is based on 2065, 45 years after the start of the spend, the NPV at other time periods are available in the CBA submission.

7.16 **Figure 22** displays the NPV of the options relative to the counterfactual (0 – Counterfactual 500 hours). [4]

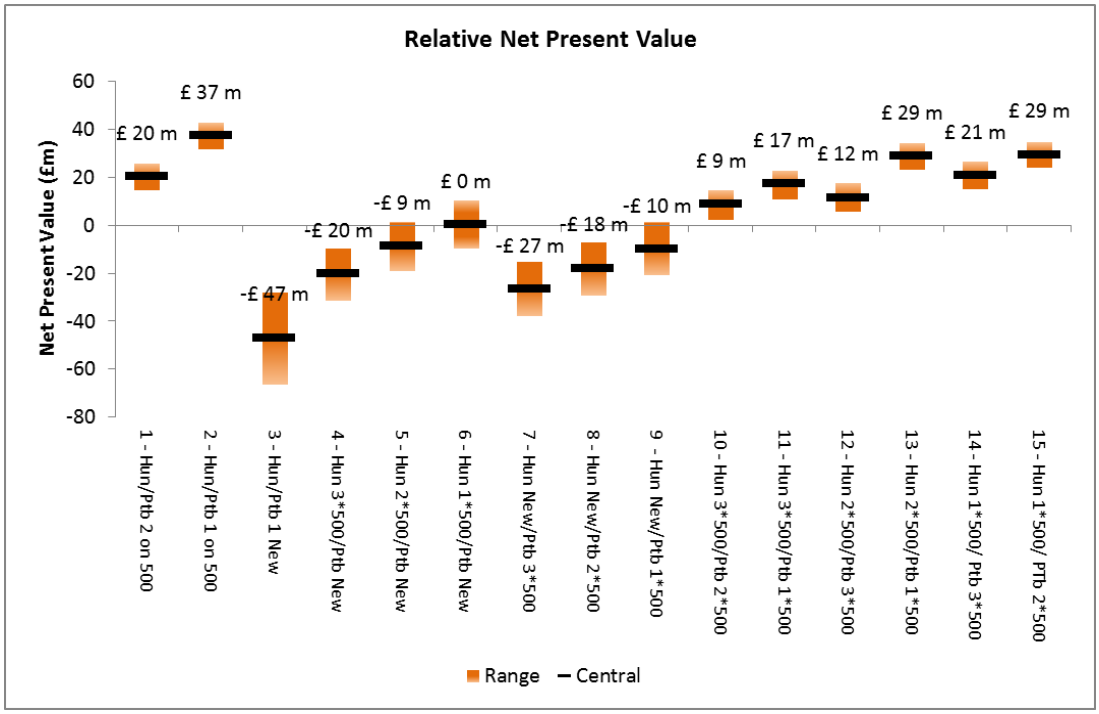

Figure 22: Relative NPV

Sensitivities

7.17 The CBA was run under all four scenarios to understand how the results could change. As shown in **Table 28** the resultant NPVs are similar across all four scenarios.

Table *28*: CBA Sensitivities[5]

Short Name	Description	Central Case – Steady Progression	Consumer Evolution	Two Degrees	Community Renewables
Option 0	0 - Hun/Ptb 3 on 500	£ 0m	£ 0m	£ 0m	£ 0m
Option 1	1 - Hun/Ptb 2 on 500	£20.2 m	£20.4 m	£20.4 m	£20.5 m
Option 2	2 - Hun/Ptb 1 on 500	£37.5 m	£39.4 m	£40.8 m	£40.9 m

[4] See footnote 3
[5] See footnote 3

Short Name	Description	Central Case – Steady Progression	Consumer Evolution	Two Degrees	Community Renewables
Option 3	3 - Hun/Ptb 1 New	-£46.9 m	-£50.4 m	-£46.7 m	-£49.2 m
Option 4	4 - Hun 3*500/Ptb New	-£20.4 m	-£22.4 m	-£20.6 m	-£22.6 m
Option 5	5 - Hun 2*500/Ptb New	-£8.8 m	-£11.0 m	-£8.7 m	-£10.6 m
Option 6	6 - Hun 1*500/Ptb New	£0.2 m	-£0.8 m	£2.3 m	£0.1 m
Option 7	7 - Hun New/Ptb 3*500	-£26.7 m	-£27.3 m	-£26.0 m	-£27.1 m
Option 8	8 - Hun New/Ptb 2*500	-£17.9 m	-£18.6 m	-£17.4 m	-£18.0 m
Option 9	9 - Hun New/Ptb 1*500	-£10.1 m	-£9.7 m	-£7.7 m	-£9.0 m
Option 10	10 - Hun 3*500/Ptb 2*500	£8.7 m	£8.6 m	£8.8 m	£8.5 m
Option 11	11 - Hun 3*500/Ptb 1*500	£17.3 m	£17.7 m	£18.0 m	£18.3 m
Option 12	12 - Hun 2*500/Ptb 3*500	£11.5 m	£11.6 m	£11.8 m	£11.7 m
Option 13	13 - Hun 2*500/Ptb 1*500	£28.7 m	£29.4 m	£29.9 m	£29.9 m
Option 14	14 - Hun 1*500/Ptb 3*500	£20.9 m	£21.9 m	£22.6 m	£22.6 m
Option 15	15 - Hun 1*500/Ptb 2*500	£29.5 m	£30.5 m	£31.3 m	£31.3 m

CBA Summary

7.18 The recommended option at this stage is to proceed to FEED with option 6 – one new 15MW unit at Peterborough and one derogated unit at Huntingdon, in preference to the highest NPV option (Option 2, one derogated unit at each site), as it provides the required resilience at one of the highest duty sites on the network, and ensures we are able to meet demands.

7.19 The highest NPV option at this stage is option 2 – Hun/Ptb 1 on 500, closely followed by option 15 – Hun 1x500/Ptb 2x500. These options all save asset health by reducing the number of Avons across the two sites. However, if demands are higher than predicted, or if there is a major issue with one of the lead units this could lead to a significant increase in constraint costs, Option 6 – Hun 1x500/Ptb New is therefore recommended.

7.20 The CBA has therefore identified three lead options that should continue to be assessed, through FEED, these are:

- Option 2: 1 derogated unit at both Huntingdon and Peterborough

- Option 6: 1 new unit at Peterborough, 1 derogated unit at Huntingdon
- Option 15: 2 derogated unit at Peterborough, 1 derogated unit at Huntingdon

8. Preferred Option Scope and Project Plan

Preferred Option for this Request

8.1 Stakeholders have told us of the importance of sufficient network capability to ensure they are able to take gas on and off the system as and when they want and that we should ensure that we are taking steps to comply with air quality legislation. Ensuring sufficient capability at Peterborough and Huntingdon is key to achieving these stakeholder needs.

8.2 In our business plan, we have proposed proceeding to FEED with option 6 – one new 15MW unit at Peterborough and one derogated unit at Huntingdon in preference to the highest NPV option (Option 2, one derogated unit at each site). Proceeding to FEED in the RIIO-2 period ensures this option can be delivered in time to achieve the identified benefits and also allows significant flexibility if at a later stage, with further information on the supply/demand pattern and volatility and results of FEED, it becomes clearer that the Option 6 level of investment is not required, at which point we could proceed with another option. We are proposing an associated UM as set out in Annex A3.02. We are not currently requesting baseline funding for expenditure post-FEED. Allowances and the price control deliverable will be set through the reopener process.

8.3 We have chosen to progress Option 6 as the basis of these proposals for the following reasons:

- Peterborough is critical to supporting 1-in-20 demand in the South West for a sustained period beyond 2030
- Our forecasts of run hours indicate a sustained requirement for around 500 hours of resilience operation at Peterborough in the long term
- Our forecast of run hours at Peterborough and Huntingdon is sensitive to changes in forecasts of demand in the South East and South West
- Additionally, our forecast does not currently include any allowance for the potential proposal to decommission or derogate compressors in the South East, particularly Cambridge, which will increase reliance on the availability of Peterborough and Huntingdon
- Therefore, derogating a single unit at each site would significantly reduce future optionality and flexibility: if we were to need to run the derogated unit for significantly more than 500 hours in a single year, for example due to a cold winter or a long outage on one of the new units, this would severely restrict use of the derogated unit for the subsequent four years of the rolling allowance.

8.4 We will continue to refine our proposals and to engage with our stakeholders as we progress with FEED to ensure that our proposals deliver an appropriate combination of cost and network reliability.

Commissioning dates

8.5 For the selected option at Peterborough (one new unit) the commissioning date is estimated to be 2029 aligned to our RIIO-2 and RIIO-3 outage plans. Decommissioning of the non-compliant units is expected to commence in 2023 (Units A and B) and 2029 (Unit C). For the selected option at Huntingdon (decommissioning two units) the decommissioning is expected to commence in 2023 for Units A and B.

Project Spend Profile

8.6 **Table 29** shows the high-level indicative project spend profile. Entries in blue, in 2023/24 and 2029/30 are for the decommissioning of existing units.

8.7 Given the current early project phase (Stage 4.1), the CBA (as a cluster) shows the delivery of the Peterborough unit between FY22 and FY27. All new unit delivery timescales are in line with this early stage assumption in the CBA. The main plan shows delivery three years later than this, between FY25 and FY30. This is the current view of when Peterborough will have outage availability to deliver this project. As the project evolves, we will continue to develop timeframes and estimates for efficient cost.

Table 29: Project Spend Profile

Unit	Driver	Action	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031
New-build MCP FEED												
Peterborough A	IPPC	Decom										
Peterborough B	IPPC	Decom										
Peterborough C	MCPD	Decom										
Peterborough x1 med new	MCPD	New										
Huntingdon A	IPPC	Decom										
Huntingdon B	IPPC	Decom										
Huntingdon C	MCPD	Derogate										

Efficient Cost

8.8 Our current costs are based on our experience of tendering for ongoing compressor replacement projects at Peterborough, Huntingdon, Hatton compressor sites and the St Fergus terminal (subject to reopener). This project will adopt our learning from ongoing compressor replacement projects covering items such as contracting strategy, surveys, bundling etc.

Project Plan

8.9 The milestones are based on our current view of investment in new compressors and expectation of the outcome of the Preliminary BAT assessment. We've also considered wider works planned across the network. Internal stakeholder engagement has identified the best time to build the new unit, so our milestones are based on this timescale. Please note, these are subject to change as the project progresses through the ND500 process. **Table *30*** is an indicative project plan showing progression through the stage gate process, purchasing of long lead items, commissioning dates and key operational milestones.

Table 30: Peterborough and Huntingdon Project Plans

Cycle	Network Development Stage Gates		Indicative Dates	
			Peterborough New Build	Huntingdon A and B Decommission
Pre-FEED Stage 4.0 and 4.1	T0	Generation of Need Case	April 2019	April 2019
	T1	Accept Need Case	April 2019	April 2019
	F1	Initial Sanction	April 2019	April 2019
	T2	Define Strategic Approach & Outputs Required to Deliver GT Handover to Delivery Unit	June 2024	June 2022
FEED Stage 4.2	F2	FEED Sanction and Feasibility Sanction Includes BAT assessment and Compressor Machinery Train selection Reopener process	June 2024	June 2022
	T3	Agreement to Proceed to Conceptual Design	June 2025	N/A
	F3	Conceptual Design Sanction and Sanction of long lead items	June 2025	N/A
Tender Award Stage 4.3	T4	Scope Freeze	September 2026	December 2023
Project Execution Stage 4.4	F4	Detailed Design AND Build Sanction (T4-F4-T5)	September 2026	December 2023
	T5	DDS Challenge, Review & Sign off Maintenance Requirements Identified	June 2027	TBC
Acceptance Stage 4.5	T6	Post Commissioning Handover to GT; Operational & Maintenance Complete or Planned	June 2029	March 2024
	F5	Project Closure	March 2030	December 2024

Key Business Risks and Opportunities

8.10 Key risks and mitigations currently identified include the following items which are summarised in **Table *31***.

Table 31: Identified key risks and mitigations

No.	Risk	Mitigation (based on current view)
1	Outcomes from BAT and tender which may influence the choice and availability of technology – possibly including hydrogen;	Undertake preliminary BAT to provide indication of possible available technology.
2	Site conditions, such as, onsite drainage and unknown buried assets, limiting options;	Engage with site to enable early above and below ground site investigations.
3	Delayed regulatory funding which could delay the projects and make tenders more expensive due to contractors having to commit to holding prices or limited numbers of contractors tendering;	Robust engagement with Ofgem.
4	Delay of completion of in-flight and proposed IPPC and LCPD projects across the NTS	Monitor current build programs and escalate potential delays to enable expeditious completion.
5	Changes in FES	Review FES on a regular basis to ensure and changes are captured early and factored into project inputs.
6	Changes in offshore operating models or new discoveries that increase UKCS supplies into Bacton resulting in lower LNG imports.	Early engagement with the Oil & Gas Authority (OGA) and environmental regulators.
7	There is a cyber security element to this project. Given the size of the cyber costs, there is a risk that external agencies may require additional levels of protection and security thus driving up costs.	Early engagement with external agencies and cyber technology providers on our preferred option and site requirements.
8	Wider changes affecting gas demand or supply such as an increase in shale gas or a move towards hydrogen not included in FES;	• Regular review and update of our FES analysis. • Proactive engagement with the wider energy industry to gain a view on trends to inform our technology choices.
9	Outages: • The overall potential volume of MCPD and other asset investment and maintenance works restricting outage availability which means Peterborough work is scheduled to start towards the end of RIIO-2. Please refer to CECS for an overall timeline; • The unpredictability of customer flows meaning that outages cannot always be agreed leading to constraint risk; • Reduced availability and/or lengthy outages at Cambridge, Chelmsford, Diss or Wisbech compressor stations, which could lead to the requirement to use Peterborough or Huntingdon more. • Appropriate flows for commissioning	• Ensure a robust deliverability plan for T2 investment is built and kept up to date on a regular basis. • Early engagement with shippers to gain understanding on current and future energy trends.
10	Land: • Building on the existing site could require lengthy outages due to working near to existing plant; • Local planning permission; • Environmental concerns during and post construction, such as noise, wildlife, water courses.	• Early engagement with local government; • Community projects.
11	Contracts: • Lead times for equipment purchase – we are a very small part of OEMs' market; • Availability of appropriate skilled resources. • High level of dependency on a single supplier (both OEM and Main Works Contractor (MWC)) – risk of being beholden to supplier.	• We will use our recent project experience at Peterborough and Huntingdon to inform our approach to internal and external resource and suppliers.

8.11 Key opportunities include:

- Bundling works with other MCPD impacted sites, bringing contracting efficiencies;
- Standardisation of our compressor fleet bringing benefits such as improved maintenance, improved operational efficiency, lower parts cost, lower inventory costs;
- Integrated design with the new IPPC compressor replacement project giving efficient site operations.
- Off-site compressor modular construction.

Outputs included in RIIO-1 Plans

8.12 Please refer to the CECS document for RIIO-1 outputs.