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Hatton IED Business Case

May 2018

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1 Executive Summary

Hatton compressor station is located in the east of the UK and has a significant role in the operation of the NTS. With nine connecting pipelines, Hatton is used across a wide range of scenarios. The station can be used to facilitate gas flows from terminals to the north such as St Fergus and Easington to support the operation of storage sites in the North West to provide demand support in the south east and to support the interconnector flows at Bacton. Hatton is a critical station, and is required for compliance with 1-in-20 obligations, which is the peak aggregate daily demand, as defined in the Uniform Network Code and which forms part of our Gas Transporters License.

Hatton compressor station is currently equipped with three Rolls Royce RB211-24 25MW gas turbine driven compressor units (Units A, B and C) and an additional 35MW electrically powered variable speed drive unit that was commissioned in 2016. Unit D is the station lead unit, whilst any of the other three units can be operated either individually or in parallel.

Hatton Units A, B and C are all impacted by the IED-LCP legislation. Unit A was put on the Emergency Use Derogation (EUD), which limited running hours to 500 hours per year in perpetuity. Units B and C are operated under the Limited Life Derogation (LLD) which allows for a maximum of 17,500 hours operation per unit or until the 31st December 2023 (whichever comes first) after which the units must be decommissioned.

The preferred option for Hatton within this submission request is for funding for one new unit. The price for this work is £40-60m.

Funding Request Summary (09/10 price base)

The Hatton funding request is £40-60m

RIIO Output: IED (LCP) emissions compliance at Hatton equivalent to one large unit.

RIIO-T1 Activities: Completion of FEED (Front End Engineering Design) incorporating recommended option. OEM (Original Equipment Manufacturer) contract awarded and unit design and FAT (Factory Acceptance Test) complete. EPC (Engineering, Procurement and Construction) contract awarded and detailed design commenced.

2 Introduction

Hatton compressor station is located north east of Lincoln in the east of the UK. Built in 1988, the station has a significant role in the operation of the NTS. Hatton Compressor Station is coupled to the Hatton multi-junction, the largest multi-junction on the NTS, which connects nine pipelines enabling the site to be configured to meet a broad range of flow patterns.

Hatton is used to facilitate gas flows from terminals to the north, such as St Fergus and Easington as well as enabling the operation of storage sites in the North West. Hatton compression is also utilised to support demand in the south east, and for interconnector flows at Bacton.

Hatton compressor station is impacted by the Large Combustion Plant (LCP) element of the IED directive. Key actions have been taken to date, with one unit operating under the EUD and two units operating under the LLD. This analysis will review those LCP decisions, in line with the LLD deadline in 2023.

3 The Site: Assets and Operation

Hatton is located on the main bulk north to south transmission route and is one of the largest combined multi-junction and compressor sites on the NTS. The compressor units at Hatton are some of the most highly utilised units in the fleet. The site is critical in providing operational flexibility and is ideally suited to support a variety of supply and demand patterns and gas flow volumes. The three significant factors influencing the utilisation of Hatton are the location of the site on the network, its connectivity to a number of different pipelines and its wide range of operating configurations.

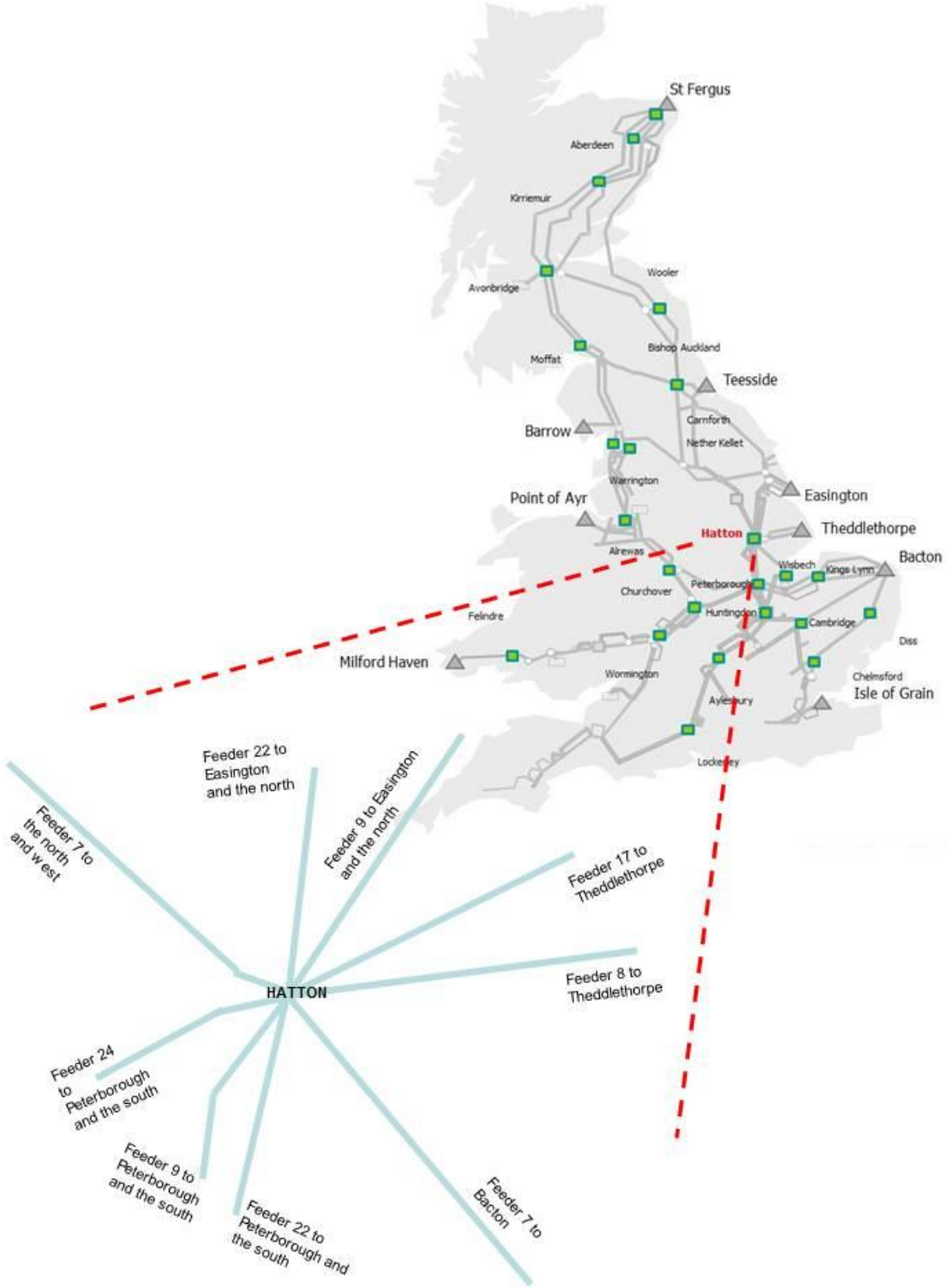

Figure 3.1: Hatton feeder connectivity

The compressor station was originally constructed over a four year period from 1988 through to 1992. At that time, the station consisted of three Rolls Royce RB211-24 25MW gas turbine driven compressor units, Units A, B and C. These units could be configured to run as single units, or as any two units in parallel.

A significant operational change occurred in 2016, when a new electric VSD compressor, Unit D was commissioned. This unit provides the base load compression, and with a maximum flow rate of 93 mcm/d, acts as the lead operational unit at the site. The station capability increased to a maximum flow of 130 mcm/d, with one RB211 unit running in parallel with the electric drive unit. In December 2017, the compressor rotor sustained serious damage which resulted in Unit D being taken out of service. It is expected Unit D will not be back online for at least 12 months.

The running hours of the four units can be seen below.

	Individual Unit Running Hours *(financial year)*				
	2013/14	**2014/15**	**2015/16**	**2016/17**	**2017/18**
Unit A	496	1063	363	200	88
Unit B	754	495	2014	1743	3466
Unit C	823	1353	1440	896	2047
Unit D	N/A	N/A	4	2549	1147
Total	**2073**	**2911**	**3821**	**5388**	**6748**

Table 3.1: Run hours summary

Looking back at the operation over the past five years, the flow range profile through Hatton is shown on the chart below.

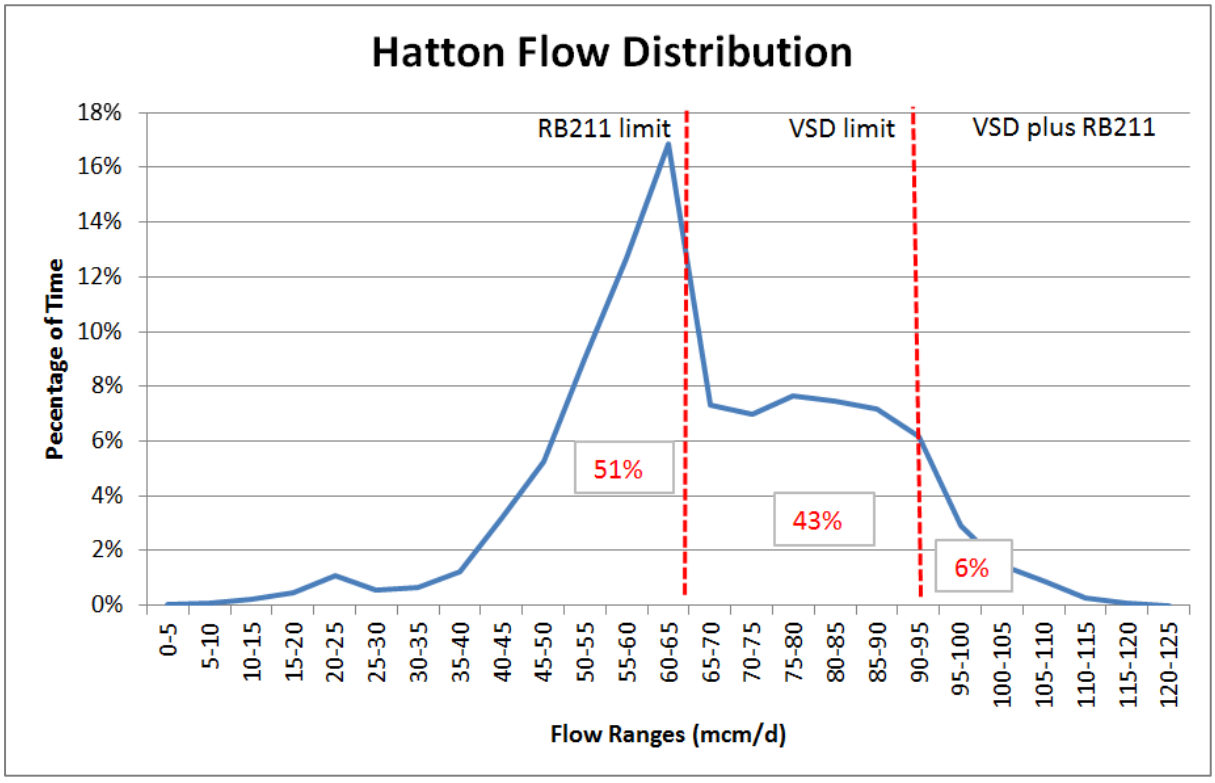

Figure 3.2: Hatton flow distribution

The VSD unit can cover flows up to 93mcm/d, above which typically one RB211 unit would be run in parallel with the VSD. The percentage of operating time within the limits of one RB211 is 51%. A further 43% is met by the higher capability VSD unit. 6% of the time flows are beyond that of the VSD, whereby two units will be run in parallel.

It can be seen from the chart below, network supply and demand conditions have led to Hatton operating in a parallel configuration for a significant proportion of time over the 5 years.

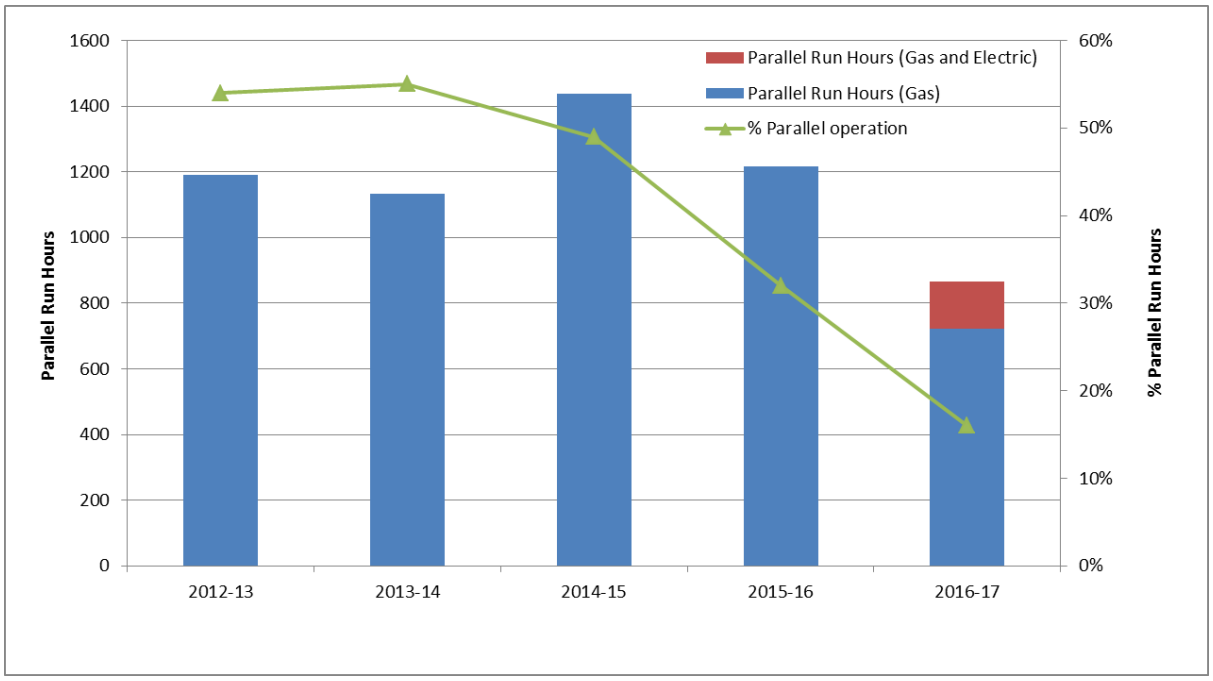

Figure 3.3: Hatton parallel operation

The operational acceptance of Unit D has clearly changed the percentage of time parallel operation is required. However the required run hours to operate in parallel are still over 800 hours per year and in the event of any unplanned outage on Unit D, one RB211 unit can only cover the flow through the site 51% of the time. It is important to note, there is a key difference between the electric and gas turbine driven compressor machinery trains. For an electric drive compressor, any significant mechanical or electrical failure of the motor is likely to result in an extended outage whilst the motor is returned to the OEM for repair (typically 6 months). The motors are effectively bespoke to each application and even where there is a similar motor in another location, it would be very time consuming and difficult to relocate even if this is operationally possible. By contrast, a failed gas turbine can be replaced within typically 3 – 5 days utilising a fleet spare, an OEM exchange engine or an engine borrowed from a low utilisation site. Any significant failure of a motor driven compressor is therefore likely to require the use of the gas turbine back-up for an extended period (a period typically greater 500 hours).

4 Emissions and the impact of IED

The LCP element of the IED applies to all combustion plants with a thermal input of 50MW or more. Under the LCP directive, combustion plant must meet the Emission Limit Values

(ELVs) for NOx and CO which are defined in the directive. All three of the RB211 units at Hatton are impacted by this requirement.

The deadline for compliance with the legislation associated with the LCP element of IED came into force on 1st January 2016 and in December 2015 a decision was made for the three individual units. The options at this stage were whether to be able to operate under either the Emergency Use or Limited Lifetime Derogations. In line with the outcome from stakeholder engagement carried out as part of our IED submission in May 2015, units B and C were put onto the Limited Lifetime derogation. At this point Unit D had not been operationally accepted, so the 17,500 hours in total under the LLD would ensure there were sufficient hours available to run the station in the period prior to Unit D becoming the lead unit. The EUD was used on Unit A. This limits the running hours to 500 hours per year in perpetuity, securing future optionality for the unit.

In summary, as part of previous investment under IPPC Phase 2 at Hatton, the new electric drive unit has largely, but not totally replaced the capability of two of the three RB211 units. These units were put onto the Limited Lifetime Derogation in December 2015. Due to the high running hours and required flexibility at Hatton this assessment has been carried out to review the requirements for high flows and resilience at the site, with a review of the LCP decisions.

5 The Future Requirements

Hatton is a critical NTS compressor stations which is required for peak 1-in-20 and to support bulk transportation of gas from north to south. The site also supports IUK and North West storage flows. The following sections detail the factors used to assess the future requirements of the site. Considerations include:

5.1 Peak 1-in-20

Hatton compressor station plays a critical role in the operation of the NTS and is required to meet our 1-in-20 obligation. The compression capability can be met primarily by Unit D but reliable and effective back up is required.

National Grid has an obligation to meet the 1-in-20 demand level, which is defined in the Uniform Network Code (UNC) and forms part of our Gas Transporters Licence. In accordance with our licence obligation, contracts must be considered essential (as specified in the Security Standard (Standard Special Condition A9)) if the physical onsite capability and back up is not sufficient to meet the 1-in-20 demand level. Contracts of this type have not typically been a core part of our compressor strategy so inherently this will introduce a higher degree of uncertainty than asset based solutions.

5.2 Bulk Transportation

Due to location and site connectivity, Hatton plays a key role in the bulk transmission of gas down the east coast towards Peterborough and the south. Hatton is connected to six feeders, three of which predominantly support flows from the north. Under high northern flow conditions, Hatton will pull gas from northern entry points to the large demand centres in the south.

Analysis carried out as part of FES 2017 indicates there continues to be a high north south split between demand and supply under all scenarios out to 2035. The role of Hatton providing bulk transportation will continue to be important in supporting these north-south ratios.

Gas flows from the north, can be routed via either the west coast (Carnforth-Nether Kellet, Warrington and Alrewas) or via the east coast using Hatton. The route via Hatton is the shortest, quickest, most efficient way to move gas from north to south. The east coast route is 463km shorter than the west coast route, and also requires fewer units, and therefore lower emissions and fuel usage.

Hatton is used to move gas away from Easington area to maximize the supply capability in the area. When Hatton is not available, gas flows across the Trans-Pennine pipeline from east to west and then south via Nether Kellet and Alrewas. This would result in a reduction in the entry capability level for the terminal.

Gas travelling this west coast route travels an additional 463km and is not able to provide Peterborough with as high an inlet pressure as Hatton, which can impact the onward transmission of gas to demand centres in the south. Under this configuration it is also harder to maintain the Assured Operating Pressures (AOP) in the North West as compression capability can be impacted by bi-directional storage flows in the north west region.

The geographical location and the configurable nature of Hatton compression combine to provide a unique and essential service in the operation of the NTS. Determination of the level of investment at Hatton therefore has an impact on the operation of the NTS overall.

5.3 High IUK export

Hatton is used to push gas towards Peterborough and onwards to Bacton to help increase pressures for IUK export. This capability is particularly important when supplies in the south through Isle of Grain LNG terminal are low.

5.4 Within day fluctuations

The multi-junction at Hatton gives a great deal of flexibility to support a range of other supply and demand patterns. Geographically, Hatton is perfectly situated to support the whole of the south of the system with multiple configurations available to support different supply and demand patterns. The alternative compression that is required if Hatton is not available is either located near to the north west storage sites or is towards the extremities of the system. This leaves the network vulnerable to changes in flows that result in multiple reconfigurations of the network and leaves the extremities of the system more vulnerable to compressor trips. For example, demand typically peaks in the first half of the day and supply is often back-loaded towards the end of the day. This can result in the network becoming unbalanced with supply entering away from the demand centres in the South. Hatton is a key station used to return the network to a balanced position ready for the start of the next gas day. Looking to the future, changes to the supply mix and changing gas and electricity interactions are likely to make these within day fluctuations more common and more extreme; the magnitude of within-day gas system stock swings has almost doubled over the

past two decades. The average linepack swing in 2016/17 was 11.5 mcm/d compared to only 6.5 mcm/d in 2001/02 and there is a notable trend for more commercially responsive customers to reconcile their positions later in the gas day.

5.5 Future requirements summary

In line with the factors outlined in the previous sections, the associated run hours forecast for Hatton continue to be high, between 3,000 and 5,000 hours to the end of price control period.

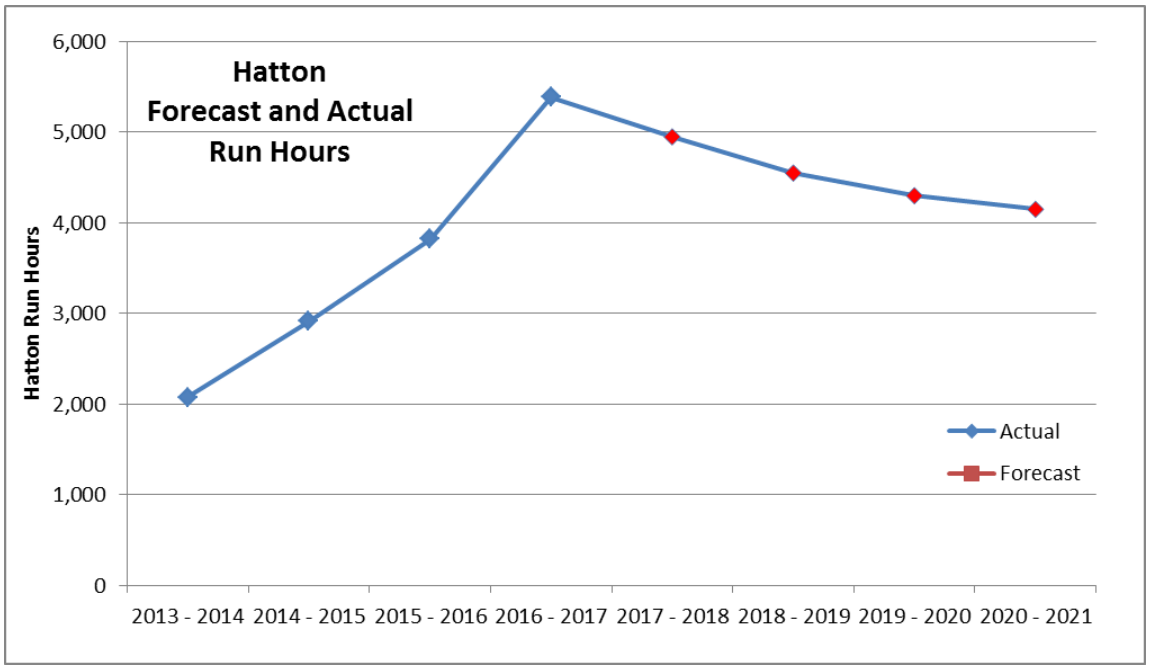

Figure 5.1: Hatton parallel operation

The various factors that influence the usage of Hatton are driven by geographical location, network connectivity and flexible capability of the site. Compression at Hatton is necessary to meet our 1-in-20 obligations, for bulk transportation and to support IUK and North West storage flows. Key considerations based on future operation and the impact of the IED are as follows:

- Unit D can meet the majority of bulk transportation, IUK and North West storage flows.
- One of the RB211 units (A, B or C) can support at lower flows or can be run in parallel with Unit D during very high flow periods.
- Once Units B and C reach the end of the LLD period, Unit A on 500 hours would be considered ring fenced for peak 1 in 20 flows.
- Once Units B and C reach the end of the LLD period, there needs to be appropriate on site back up for Unit D, and for parallel operation at the higher flows.

The robust assessment of investment options at Hatton is critical to ensure we can meet the future network challenges, particularly to deal with network uncertainty and increasing within day fluctuations.

6 Options Overview

The options available for Hatton form part of the Cluster network analysis and associated CBA. The asset options cover a range of possible solutions for the provision of capability and back up for Unit D and alternative possibilities for investment in either the east or west coast gas transmission routes. The asset options described below are considered in conjunction with a suite of commercial and regulatory options as part of the Cluster approach.

6.1 The Counterfactual

Based on the likely future usage of the site, a counterfactual option was defined. This option is the closest to business as usual and which is compliant with all the relevant elements of IED.

The counterfactual option (Option 0)is to continue with Unit D, the electric drive unit as the lead operational unit. Unit A would continue to be operated under the Emergency Use Derogation (EUD), with the associated limit of 500 hours per year in perpetuity. Units B and C would continue to operate under the Limited Life Derogation which requires that the units cease operation after 17,500 operating hours or the 31st December 2023, whichever comes soonest. These units would subsequently be decommissioned post 2023. In order to comply with our 1-in-20 obligations, Unit A on 500 hours per year should be considered ‘ring fenced’ for those peak requirements.

In order to evaluate the true economic case for the counterfactual, a number of other commercial and physical options have been assessed for the purposes of comparison. These options have been developed through a process of stakeholder engagement including previous feedback generated for the May 2015 reopener, site asset and operational assessments and investigation and assessment of new technology. The new units considered are both medium (15MW) and large (30MW) sized units. A number of options were considered but discounted including brownfield options due to the operating constraints on the site and the current status of Unit D.

6.2 Physical Options

Looking at the standalone options for Hatton seven options in addition to the counterfactual are considered.

Option 1

Under this option, Unit D remains the lead unit and all three Units A, B and C are decommissioned post 2023. Under this option assessment back up and resilience are provided via commercial contracts and from other stations.

Option 2

This option continues to provide lead operational capability from Unit D, and Unit A operates under the 500 hour limit of EUD. Unit B is decommissioned post 2023. Emissions abatement technology is fitted to Unit C, which then operates without the restrictions of the EUD. Due to the limitations of the unit operating under EUD, and only investing in one unit with emissions abatement, commercial contracts will also be required under this option.

Option 3b

Under this option Unit D continues to be the lead unit and Unit A runs under the EUD until the new units are available. Two new 15MW units (Units E and F) are installed on a greenfield location. Units A, B and C are decommissioned post 2023.

Option 4

Under this option, Unit D continues to operate as the lead unit. Emissions abatement technology is fitted to Units A and B. Unit C operates until LLD until 2023, after which it is decommissioned.

Option 5b

Under this option three new 15MW units (Units E, F and G) are installed on a greenfield location. Following the commissioning of new units, Unit A is decommissioned. Units B and C are decommissioned post 2023. Unit D is retained as is.

Option 6

Under this option, the VSD Unit D is kept as is. Units A, B and C are all fitted with emission abatement technology.

Option 7b

Under this option the VSD Unit D is kept as the lead unit. Unit A is retained under 500 hrs on EUD and one new unit (30MW) is installed on a greenfield site. Units B and C are decommissioned post 2023.

The options cover a wider range of capability, and as presented in the table below, three of the options will require commercial contracts for us to meet our obligations under 1-in-20 and other system requirements.

	VSD 93mcm/d	RB211 on EUD 65mcm/d for 500 hours	Unrestricted RB211 65mcm/d	New Medium Unit 30mcm/d	New Large Unit 93mcm/d	Total inc 500 hours restriction*	Contracts Required	Capability
Current	93	65	130	0	0	288	No	
Option 0	93	65	0	0	0	158*	Yes	
Option 1	93	0	0	0	0	93	Yes	Low
Option 2	93	65	65	0	0	223*	Yes	Medium
Option 3b	93	0	0	60	0	153	No	Medium
Option 4	93	0	130	0	0	223	No	High
Option 5b	93	0	0	90	0	183	No	Very High
Option 6	93	0	195	0	0	288	No	Very High
Option 7b	93	65	0	0	93	251*	No	High

Table 6.1: Option capability

7 CBA Assessment

The recommended option for Hatton was developed as part of the Cluster covering both east and west coast investment choices. This is an important feature of the business case, whereby the site specific impact of IED on individual units is also considered in an integrated manner with options and considerations across other network sites. The analysis considers capability at Carnforth-Nether Kellet, Huntingdon, Peterborough, Alrewas and Wisbech as well as Hatton.

For Hatton, the process is a two part process; the counterfactual plus seven other options are compared within an initial CBA, including investment costs, asset health costs and OPEX, but not contract costs. The initial CBA provides the basis for selection of a short list of options to take forward to the Cluster analysis. A second CBA is generated as part of the Cluster considering a matrix of different capability levels at all the relevant sites. These capability levels are then used to determine the required level of commercial contracts. The contract costs are then included in the Cluster CBA. Please refer to the Integrated Plan chapter for more detail on this part of the process.

The NPV for all the Hatton options is presented below. The values range from -£47m to -£180m across the eight options, which assesses investment costs, asset health costs and opex. Option 1 has the most favourable NPV, -£47m, with the counterfactual NPV fairly similar at -£50m. Option 2 has a NPV of -£94m. These options would all require contracts to support the station requirements, including the 1-in-20 obligation.

Of the options not requiring contract, Option 7b looks most favourable at -£123m, which is fairly close to Option 4 (-£135m). Option 3b and the two very high capability options 5b and 6 are -£165m, -£180m and -£161m respectively.

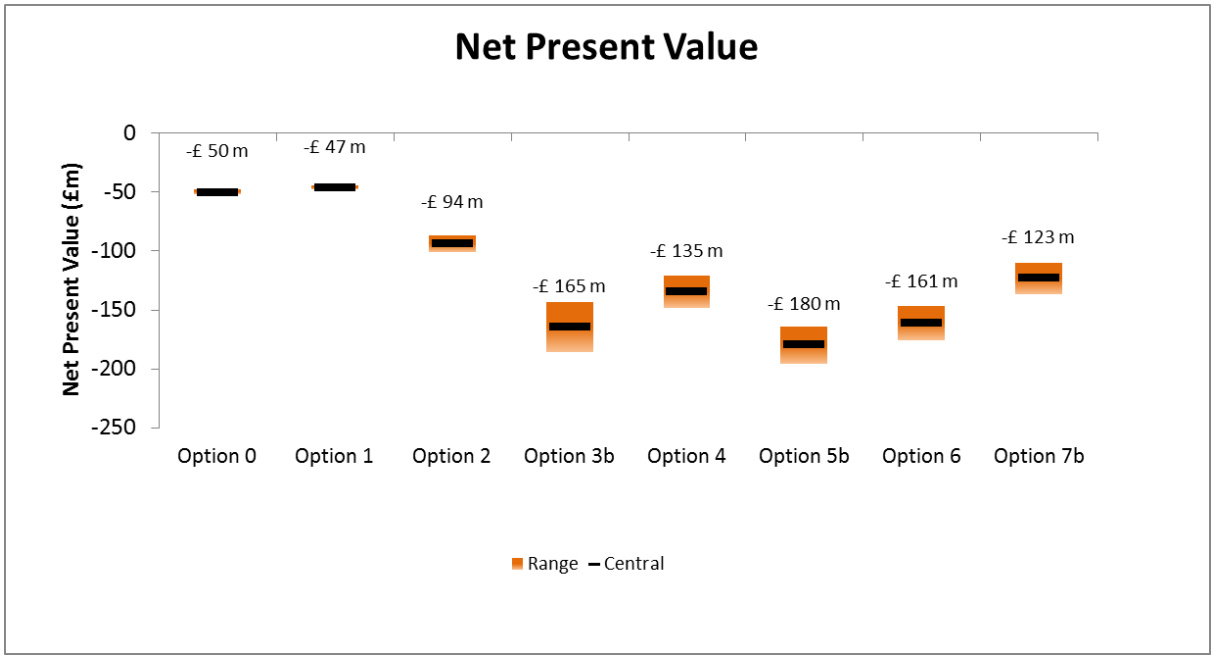

Figure 7.1: NPV for Hatton options

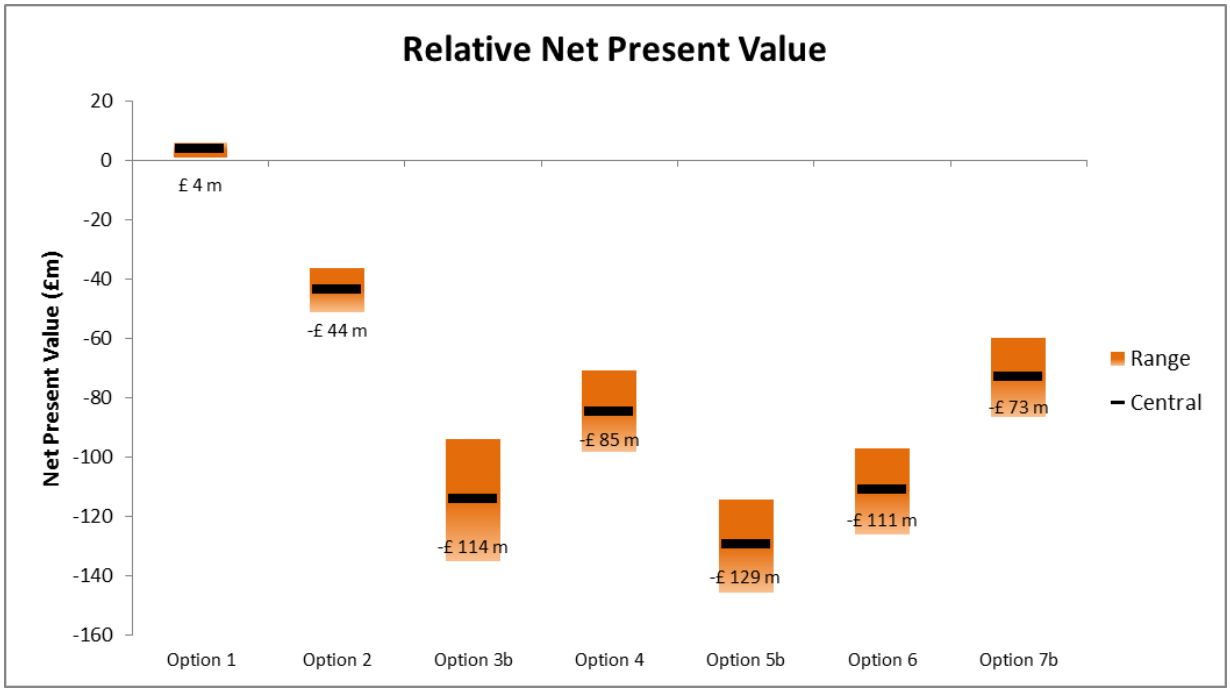

Figure 7.2: Relative NPV

Looking in more detail at the costs, Option 3b has significant costs associated with the new units. Option 2 has lower investment costs than Option 3b but higher station OPEX associated with the ongoing operation of the emission abatement. Based on this initial CBA, Option 1 offers advantages over the counterfactual, with no ongoing costs associated with the RB211 unit. The higher capability options 5b and 6 have high investment costs, and also high ongoing asset health associated with the number of units on site. Option 6 has high OPEX linked to the ongoing operation of three units with emissions abatement.

In summary, Option 0 and Option 1 have the lowest NPV with relatively low investment and asset health costs. Option 2 with investment and ongoing OPEX associated with emissions abatement on one unit is the next most favourable. Although not costed in at this stage all these options would require contracts in addition to the physical capability in order to meet the 1-in-20 requirements. Option 7b is the third most favourable option with investment in one large new unit, but requires no contracts. As a high capability option, this option looks particularly favourable particularly when compared to the additional investment and OPEX costs associated with the two SCR units under Option 4. Options 3b, 5b and 6, which require investment in two new units and three new or abated units, are the least favourable.

Based on this initial assessment, the most likely options are then validated through the cluster analysis to give a holistic view of the benefits of east coast versus west coast investment.

The counterfactual, Option 0 is automatically taken forward to the Cluster analysis. Option 1 has the lowest costs and is taken forward as the low capability option and Option 2 is taken forward as the medium capability option. Both Options 4 and 7b are taken forward as high capability options. None of the very high capability options are selected so in total five options are taken forward.

At this stage, Option 1 looks slightly more favourable overall than the Counterfactual and Option 7b would be the most favourable of the options not requiring contracts. The next part of the analysis is described in the Integrated Plan chapter which explores the impact of the contracts with the five options combined with other proposed investments on the network. The recommended option is therefore one which is validated through the cluster analysis.

8 Stakeholder Engagement

The consultation for this reopener builds on the comprehensive programme of stakeholder engagement undertaken in 2015. In addition to a series of workshops in October 2016, we have conducted several bilateral meetings with interested parties and have incorporated their views. In January and February 2018 there were two presentations at the Transmission Working Group, sharing the analysis and taking questions from stakeholders. There has been a formal consultation which opened on the 14th March and closed on the 13th April 2018. There were no concerns raised regarding the Hatton options, analysis and proposed recommendation.

9 Recommended Options

Option 7b is the chosen option as per the Integrated Plan chapter. The Cluster analysis demonstrates the benefits of an east coast route for gas transmission versus the west coast.

The benefits of physical investment at Hatton, rather than significant reliance on contracts to support network requirements are demonstrated through the Cluster. The Counterfactual and the low capability options for Hatton are therefore discounted. The medium capability option, Option 2 is slightly lower cost (-£55m) than the high capability option, Option 7b (-£66m). However, the medium capability option does still require contracts to meet a range of likely scenarios. Contracts of this type have not typically been a core part of our network strategy so inherently these contracting levels introduce a higher degree of uncertainty than asset based solutions. The current contract price assumptions are based on existing OM tender prices, use of contracts under a wider range of network conditions will introduce a higher level of risk that prices rise sharply once these contracts are called upon, and also that the required changes in flow are not seen when called upon. At a network critical station like Hatton, the emissions abatement introduces further risk with the use of an innovative technology and not yet proven on the NTS.

Although this Option 7b costs circa £6m more than Hatton Option 2, the cost ranges overlap significantly, and this expenditure would provide capability certainty at a critical station, without the additional year on year contractual risk. Hence the high capability option, Option 7b for Hatton is recommended. Under Option 7b, one large new unit is constructed on a greenfield location, and Unit A is retained on the EUD. Units B and C are decommissioned post 2023. This option requires no further contractual arrangements to meet the future needs of the site.

10 Delivery

The initial sanction of the Hatton investment was made in December 2017, the output from which defined the strategic approach for the site. Investment in one large unit is the recommended option however the FEED process will determine the final solution. Incorporating the preferred options from the CBA, the FEED and feasibility sanction was approved in May 2018.

11 Conclusion

This submission assesses the options to manage the implications of the LCP directive at Hatton. The recommended decision is to invest in one large unit at Hatton. The price for this work is £40-60m.

Funding Request Summary (09/10 price base)

The Hatton funding request is £40-60m

RIIO Output: IED (LCP) emissions compliance at Hatton equivalent to one large unit.

RIIO-T1 Activities: Completion of FEED (Front End Engineering Design) incorporating recommended option. OEM (Original Equipment Manufacturer) contract awarded and unit design and FAT (Factory Acceptance Test) complete. EPC (Engineering, Procurement and Construction) contract awarded and detailed design commenced.

RIIO-T1 Expenditure Risk – The risk of not completing the works prior to 2021 is medium. The F2 sanction has been approved and the F3 sanction will be due for approval in May 2019.