Engineering Justification Paper

Shatterling PRS Pre-Heating System Replacement

Final Version

Date: December 2019

Classification: Highly Confidential

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2 Introduction

This project is one element of the Transmission Integrity programme within Southern Network for RIIO GD2. The integrity programme is generally health driven considering the health of transmission assets - offtakes, local transmission system (LTS) pipelines, pressure reduction stations (PRS) and ancillary assets. 'Health' includes condition (corrosion, cracking, spalling etc.) and reliability (in-service defects etc.).

In terms of engineering justification, the Authority has proposed the following model to differentiate between 'major projects' requiring justification in accordance with Appendix A guidance and 'asset health' projects justified in accordance with Appendix B.

Major Project	Asset Health
• Named scheme	• Spend on one asset class
• 'Capex' multi-discipline	• Single / limited discipline
• Geo-defined scope	• Geo-diverse
• Delivers new service	• No change to plant
• New design	• Similar / same scope
• Higher risk spend	• Routine spend

Bespoke estimate ◄ Uncertainty ► Unit costs / last costs

Guidance for engineering justification

The engineering justification for the majority of Transmission Integrity projects has been classified as 'asset health' and has been drafted in accordance with Appendix B since they are related to one asset class, are of limited discipline, relate solely to refurbishment or replacement of plant and have limited uncertainty. The Engineering Justification for the interventions at Shatterling PRS has been prepared in accordance with Appendix B.

This project is to replace the heating and systems at Shatterling PRS and will remove the risks associated with the site for 6,200 customers. This component replacement has been identified as the only acceptable engineering solution, as there are no issues with the other key components on site. This project is to replace the existing heating systems and includes the installation of new boilers and heat exchangers.

General Background

Shatterling PRS is in the county of East Kent, within Dover District Council and supplies natural gas at a rate of 15,450 scm/h to industrial users to the east of the PRS. The site is also near to the A257 main road from Canterbury to Sandwich.

Security

The HP to IP PRS was designed and installed in 1991/92 to meet increasing industrial gas demand in East Kent.

Site Specific Background
Shatterling PRS is contained within a compact, above ground and secure site, bordering a rural area just north of Shatterling village. The existing PRS and gas pre-heating system was installed 28 years ago as a new 'green field' site to meet increasing, industrial gas demand. The system of pre-heating used at the time was considered an innovative, low cost, compact and a simplified approach. This heating equipment is now obsolete, worn, at the end of its operational life and does not meet the requirements of IGEM/TD/13. It also contravenes SGNs Policies and standards regarding security of gas supplies, safeguarding downstream pipework integrity and operational reliability. The existing pre-heat system is also based upon non-condensing technology and has an energy/heat transfer efficiency of around 50% to 60%, that falls far short of SGN's energy conservation and environmental impact targets and policies.

3 Equipment Summary

SGN's wholly owned Shatterling pressure reduction station reduces the gas pressure from High Pressure, up to 38 barg, into a 5.8 barg Intermediate Pressure network that runs from Shatterling to Great Stonar within the Dover District of East Kent. The PRS is essential for supplying gas to three, downstream, Distribution, governors, to provide LP gas to customers at a temperature of not less than $+0^{0\,C.}$ The PRS at Shatterling is critical and dedicated for industrial gas supplies and is fed from a 450mm nominal size buried HP pipeline denoted Grid Main 12. Shatterling supplies gas to 6,200 customers

Security

The original gas pre-heating system at Shatterling was considered an innovative approach. This type of heating system was first introduced in the early 1990's following a review of the heating requirements philosophy and was considered to offer better value due to its simplicity and reduced cost and infrastructure. The heating system at Shatterling was installed in line with this philosophy, as part of a programme for sites with smaller gas demand. The system comprises of a small, singular, compact, carbon steel bodied, gas fired water bath heater, where hot exhaust gas heats a water vessel at atmospheric pressure. The heat is transferred internally to the HP gas transmission pipework, so pumps are not required. After ten years operational experience and performance monitoring, this low cost, non-condensing, moderate risk-based approach was revoked. A new, fully compliant risk based approach has been adopted and implemented, with stand-by facility and far better reliability and temperature control.

With low cost installations of this type there is usually no stand-by heating capacity, contravening the philosophy and minimum standard set by the Institute of Gas Engineers and Managers design standard IGEM TD/13. There have been numerous heating system failures for this type, that have exposed the network to integrity, supply and safety risks, associated with freezing outlet gas and pipework temperatures.

Other site equipment:

- PRS stream inlet and outlet isolation valves
- Filters
- Pre-heating system pipework and connections
- Protective slam-shut valves
- Regulators
- Non return valves

200mm nom size 'Plenty - SPX' gas process filters.

One water bath heater vessel fitted with a 'Lanemark Combustion Engineering Ltd' 'TX' series, gas fired, process burner, with immersion tubes and inlet air and exhaust fans.

An elevation of the WBH with thermal insulation

'Lanemark' gas burner control system

Two 100mm nominal size 'Tartarini - BM5' inlet slam-shut valves, that are the PSSR 'Primary protective devices' for protecting the downstream system from PRS malfunction and over-pressurisation.

Two per stream, 100mm nominal size 'IGA – Axial Flow' regulators, configured for 2 stage pressure reduction.


First stage pressure reducing regulator


Second stage pressure reducing regulator

Global population
SGN has the following numbers of Offtakes and PRS within Scotland and Southern networks (as reported during the 2018/2019 RRP):

Network	Offtakes	PRS
Southern	12	157
Scotland	18	131

Pre-heating system
The majority of these sites have gas pre-heating systems as follows:

Type	Southern		Scotland	
	Offtakes	PRS	Offtakes	PRS
Boilers / heat exchangers	6	133	6	44
Water-bath heaters	6	19	10	61
Electrical element	-	3	-	4

4 Problem Statement

Why are we doing it?

The sites pre-heating system is non-compliant with IGEM TD/13 as there is no stand-by/back up heating facility. In addition, the existing, 'Lanemark' gas fired combustion burner system is obsolete and at the end of its operational life, where essential repair components and manufacturers support are not readily available. In the event of a major fault, there could be a long-term outage of the sites sole gas heating system. If the site is not isolated, this puts the downstream network at risk from extremely cold gas entering the Polyethylene (PE) and cast iron mains network. This could lead to pipework failures, resulting in uncontrolled gas releases and significant loss of gas supplies.
The rebuild of Shatterling PRS heating system, will ensure the current risks associated with insufficient heating capacity and condition are removed and will significantly decrease the installations monetarised risks.

Loss of gas pre-heating would result in extremely cold gas e.g. between -12 ^{0}C to -20^{0} C, entering the downstream, Polyethylene mains and services. This could result in pipework embrittlement, fractures, ground/ frost heave, subsidence and consequential uncontrolled gas escapes. Damaged, or suspected damaged pipework and structures will have to be removed and replaced.

Should the gas pre-heating system fail at Shatterling PRI, during Winter conditions, then up to 6,200 customers will be at peril of losing their gas supplies.

The project will be successful if delivered on time, within budget, to the SGN specification, with minimal maintenance requirement and no impact upon customers.

Impact of 'do nothing' approach

Failure to deliver the intervention to replace the pre-heating system will leave the existing system at a real risk of failure. The pre-heating system negates the loss of gas temperature during pressure reduction, a phenomenon known as the Joule-Thomson effect. A pressure reduction of up to 33BarG will result in the loss in temperature of around 17^{0}C. Gas enters the site at temperatures down to around 5^{0}C meaning that gas could leave the site at -12^{0}C, far below the acceptable operating temperatures for PE pipelines, which starts 30m from Shatterling PRS. The consequences include pipeline rupture, ignition and death, potential loss of supply to customers or frost heave along the pipeline route, across roads and other transport infrastructure.

Failure to deliver the intervention to replace the heating system, would lead to a prolonged outage if they were to fail. As the equipment is obsolete and no spares are available, the outcome would be a potential loss of supply to customers.

How do we know we have achieved the outputs

The project will be successful if delivered on time in budget and with no impact on customers. Monitor the sites performance of the site through the gas control DNCS, monitoring the gas outlet temperature and gas outlet pressure and performance monitoring through both routine maintenance and pressure systems inspection results.

Spend Boundaries

The project will replace the sites existing gas fired water bath heater, controls and dedicated auxiliary equipment. Exactly how this will be achieved will be determined at the start of the design and costing phase for the project. It is anticipated that this will entail modifications to the sites HP inlet pipework, installing a new fuel gas supply for the pre-heating system and modifications to the on-site electrical and instrumentation systems associated with the replacement equipment.
A small, preferably gas fired electrical generator will also be installed to ensure that the new pre-heating system will continue to operate in the event of loss of the sites incoming electrical supply.
The existing stream filters, regulators, valves, including protective slam-shuts will not be replaced as part of this project but will be subject to further inspection for performance, condition and defects during RIIO-GD2.

The spend of this project is to replace the existing, pre-heating system at Shatterling PRS and associated electrical, instrumentation and auxiliary equipment. Dependent upon the type of replacement, this could include modifications to the HP inlet pipework for two new in-line heat exchangers, connected to a compact boiler house with stand-by facility and LP gas supply. The boiler house will require concrete foundations and at least two gas fired, condensing boilers and associated, thermally insulated flow and return, heated water pipework.

This work is to be completed as a PRS 'partial rebuild', which is the most cost-effective method of reducing the current risks. Complete rebuild of the PRS has been discounted, as this would renew components that do not require replacement within GD2 and therefore not a cost-effective option.

5 Probability of Failure

Failure rate

In the NARM framework 'failure rate' is used to calculate the Probability of Failure. The failure rate gives the rate of occurrence (frequency) of failures at a given point in time and may also include an age/time variable, known as asset deterioration, which estimates how this rate changes over time. The failure rate can be approximated by fitting various parametric models to observed data to predict failures now and in the future. Therefore, data that contributes towards monetised risk value has been thoroughly reviewed for each system under this investment.

Failure modes

In the NARMs methodology the failures are categorised into different Failure Modes. Below is list of all failure modes considered in the methodology and any data modification made to the model.

Pre-heating

- **Release of Gas** - *relating to the failure of a pressure containing component on site leading to an unconstrained release of gas within and possibly off the site.*
- **High Outlet Temperature** - *relating to the failure of the pre-heating system to provide the correct heat input for that associated site gas flow rate resulting in high outlet temperatures.*
- **Low Outlet Pressure -** *relates to the failure of the pre-heating system to provide the correct heat input for that associated site gas flow rate resulting in low outlet temperatures*
- **Capacity -** *where the system has insufficient capacity to meet a forecast 1:20 peak day winter, downstream demand*
- **General failure -** *relates to other failures not leading to release of gas, low/high outlet temperature or capacity failures.*

Pre-heating		
Asset Attributes	**Modification**	**Reason**
CONDITION_SCORE	Score updated from 1 to 4	No redundancy/stand-by - heating on single stream only
NO_EFFECT_PRS	Changed from 1 to 0.8	5 faults recorded on the heating system over the last 6 years. This equates to 0.8 fault per year
LOW_OUTLET_TEMPERATURE	Nil	Not available

5.1 Probability of Failure Data Assurance

SGN's NARM's model has been developed based on methodology agreed for all gas networks with Ofgem which users require a set of base data. The base data for this site was the output of an extensive and component focused data collection exercise conducted in 2011.

Health and Criticality – Shatterling PRI Preheating		
Asset Attributes	**Rating**	**Reason**
CONDITION_SCORE	Score **4**	The WBH pre-heating system was commissioned in 1992. The 2011 Asset Condition Score was derived as HI-2, but

		reclassified HI-4, based upon obsolescence and no essential spares. The site has not had any integrity, nor uprating work completed on the pre-heating system for 28 years operation. The pre-heating system, instruments, controls and associated fuel gas pressure breakdown are reaching the end of their operational lives.

Below are the failure rates derived from the model for the failure mode:

Preheating

Failure Mode	2021	2022	2023	2024	2025	2026
Release of Gas	0.08	0.10	0.11	0.13	0.16	0.18
General Failure	0.65	0.77	0.90	1.06	1.24	1.45
High Outlet Temp	0.01	0.02	0.02	0.02	0.03	0.03
Low Outlet Temp	0.97	1.14	1.34	1.57	1.84	2.16

Failure Rate Table – Pre-heating

6 Consequence of Failure

In the NARM methodology Consequence of Failure is analysed for each failure mode and every Consequence of Failure has an assigned Probability of Consequence (PoC). This is determined through consequence analysis techniques such as:

- Statistical analysis of associated failure data
- HAZOP techniques (Risk assessment)
- Historic incident data
- GIS (Geographic Information System) analysis
- Network modelling analysis

Each Consequence of Failure in the model have an associated financial cost (Cost of Consequence), based upon the type and scale of impact, representing a monetary risk value. These Consequence of Failure are split into the following categories:

- Customer Risk – Loss of supply
- Health and Safety Risk – Death, injuries, property damage, etc.
- Environmental risk
- Other financial Risk – Repair, Maintenance, etc.

The below Matrix plots the credible failure modes against how severely it will affect each of the consequences. These are colour coded to give a visual representation of the likely impact:

	Failure Consequence		
Failure Mode	Security of Supply	Safety Impact	Environmental Impact
Pressure Regulating Equipment (Both Slamshuts Closed)	Security of Supply would be lost for a significant quantity of customers with both slamshuts closed	No direct effect	No direct effect
Pressure Regulating Equipment (Overpressurisation of Outlet) control equiment freezing as heating system failed.	If overpressurisation causes a significant escape, security of supply could be affected	Safety impact is elevated compared to escape within the site, as this could affect pipework within proximity to the general public	Carbon emmissions proportionate to the volume of the escape
Preheating Equipment (Failure at winter, brittle fracture due to cold temperatures)	If brittle fracture causes a significant esacpe, security of supply could be affected	Safety impact is elevated compared to escape within the site, as this could affect pipework within proximity to the general public (although chilling will be most severe closer to the site).	Carbon emmissions proportionate to the volume of the escape

7 Options Considered

Within this Engineering Justification Paper for there are 4 options which have been considered and discussed to address the pre heating at Shatterling PRS. The 4 core options being considered are as follows:

- Replace on Failure
- Repair on Failure
- Pre-Emptively Replace
- Pre-Emptively Repair

When considering this intervention, we have done so following our 4R strategy. This strategy is designed to maximise the asset life and minimise the capital expenditure of intervention and in doing so sets out an order of preference for the intervention type. This order is key in delivering customer value and focuses on the lighter intervention options of repairing and refurbishing the asset before considering more severe interventions such as full replacements of the existing assets. See below for an illustration of our 4r strategy:

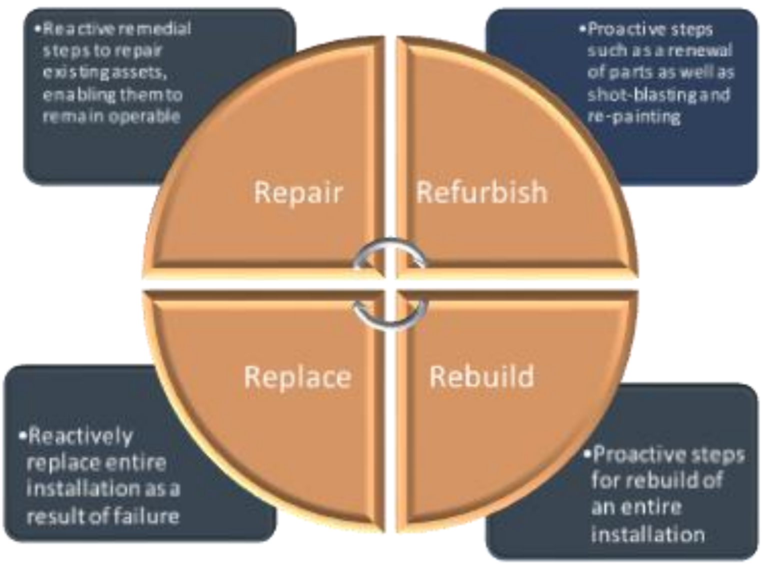


Diagram of 4R Strategy. Repair and Refurbish options at the top are considered before resorting to Replace or Rebuild at the bottom

Following this strategy, the options of a reactive repair or proactive refurbishment are typically considered ahead of proactively rebuilding the site or carrying out a replacement reactively.

7.1 Do nothing

This option has been discarded due to no redundancy or stand-by facility within the sites existing heating system. There is also limited heat capacity and lack of serviceable components such that breakdown of failure would lead to loss of gas supplies for significant periods.

7.2 Refurbish components

Refurbishment of components is not an option as the equipment is obsolete and spares are not available should derive a short-term extension of the life of the asset. However, refurbishment has already been attempted to both the pre-heating and volumetric control systems with limited or no success.

7.3 Replace on failure

With key replacement equipment being on long lead times, should the equipment fail, the heating system would not be available for a prolonged period. This would put the downstream system at high risk for supply failures and gas releases.

7.4 Repair on failure

This option has been discounted as there is no stand-by facility within the sites existing heating system. Component or system failure would quickly lead to sub-zero gas temperatures and potential long-term heating system outage. Unless the site is isolated, this will greatly increase the risks for loss of outlet gas supply, consequential pipework failure resulting in uncontrolled gas escapes.

7.5 Preheating Replacement

The option to replace the sites heating system is the preferred option. The new and replacement system will be fully serviceable, include a stand-by heating facility, with increased thermal efficiency and more accurate temperature control.

The technical detail of the option i.e. capacity, system rating, availability etc.

The new heating system at Shatterling PRS, has been designed to incorporate the predicted load growth for the next ten years, 15.45kscmh and has a heat requirement of 86Kwh, with 100% redundancy in accordance with IGEM TD/13.

The basis for the cost estimate/unit cost

Following an initial costed design by Rush Construction, in report “SGN GD2 Mechanical & Civil Budget Analysis” SGN Trans - 014Shat - EJP Dec19_SupportingCosts.pdf the costings were reviewed by SGN Major Projects using experience from GD1.

Security

The perceived benefits of the option

Removal of immediate risk to 6,200 customers for both security of supply following a failure of the regulators, with the associated long lead time on key pieces of equipment and risk of exposing the outlet to extremely cold gas with the potential creating gas leaks, frost heave or poor control of the PRS or the local district governor regulators.

Delivery timescales

2024 - Design
2025 - Procurement

2026 – Main Works Contractor
2026 – decommissioning and removal of redundant system

Key assumptions made

Major projects identified additional costs from the desk top exercise, these include bringing the below ground control room to a new kiosk above ground, demolition of the existing boiler house. With the cost of the main works contractors increasing significantly, based on experience of current projects.

Any other items that differentiate the option from the others considered

This is the only credible option.

7.6 Options Technical Summary Table

Table – Options Technical Summary

Option	First Year of Spend	Final Year of Spend	Volume of Interventions	Total Cost
1. Preheater replacement	2024	2026	One heating system	£1.43m

7.7 Options Cost Summary Table

Table – Cost Summary

Option	Cost Breakdown	Total Cost (£m)
1. Preheating replacement	See report attached "SGN Trans - 014Shat - EJP Dec19_SupportingCosts.pdf"	£1.43

Projects costing have been achieved through the following process and includes contingency numbers, efficiencies and overheads to give the total gross cost:

- Initial scoping of works including design parameters,
- Desk-top feasibility study using design consultants with full awareness of GD1 projects,
- Contact with manufacturers,
- Additional assessment by Project Managers to take into account local site conditions, constraints and costing information based on recent projects. Including increasing significantly the cost for the main works contractors.
- Review by Asset Manager

8 Business Case Outline and Discussion

The system is a critical supply to the MP system. The main drivers for a complete a heating system replacement, is non-compliance with IGEM TD/13 no stand by heating availability and the heating system is obsolete equipment, which would have a prolonged outage if a component failed. Failure to deliver this work, will put the 6,200 customers at risk pf losing their gas supplies, potentially for up to a year. A number of interventions have been considered. However, the benefits are considered inadequate in mitigating the current issues.

8.1 Key Business Case Drivers Description

Table – Summary of Key Value Drivers

Option No.	Desc. of Option	Key Value Driver
1	Repair on failure	Potential, long term loss of supply to customers, safety and environmental impact due to cold fracturing
2	Preheater replacement	Continuity of supply and reduction in both safety and environmental risks associated with the loss of heating and brittle failure of the downstream systems

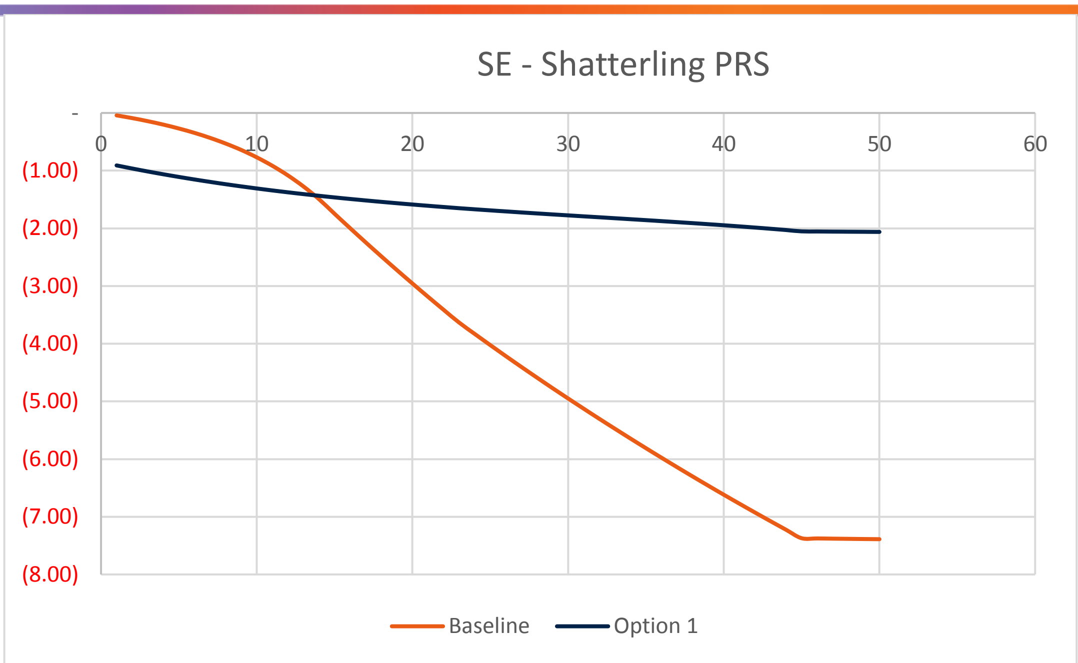
Table – Summary of CBA Results

NPVs based on Payback Periods (absolute, £m)								
Option No.	Desc. of Option	Preferred Option (Y/N)	Total Forecast Expenditure (£m)	Total NPV	2030	2035	2040	2050
Baseline	Repair on failure / Do minimum	N	-0.09	-7.39	-0.64	-1.49	-2.72	-4.77
1	Option 1 Absolute NPV	Y	-1.51	-2.06	-1.27	-1.44	-1.56	-1.76
1	Option 1 NPV relative to Baseline	Y	-1.51	-2.06	-0.63	0.06	1.16	3.01

8.2 Business Case Summary

	Preheater Replacement
GD2 Capex (£m)	1.43
Number of Interventions	0.00
Carbon Savings ktCO2e (GD2)	271.50
Carbon Savings ktCO2e /yr	54.30
Carbon Emission Savings (35yr PV, £m)	0.36
Other Environmental Savings (35yr PV, £m)	0.00
Safety Benefits (35yr PV, £m)	4.85
Other Benefits (35yr PV, £m)	0.01
Direct Costs (35yr PV, £m)	-1.27
NPV (35yr PV, £m)	3.95
High Carbon Scenario	
Carbon Emission Savings (35yr PV, £m)	0.54
High Carbon NPV (35yr PV, £m)	4.13

Table - Business Case Matrix



9 Preferred Option Scope and Project Plan

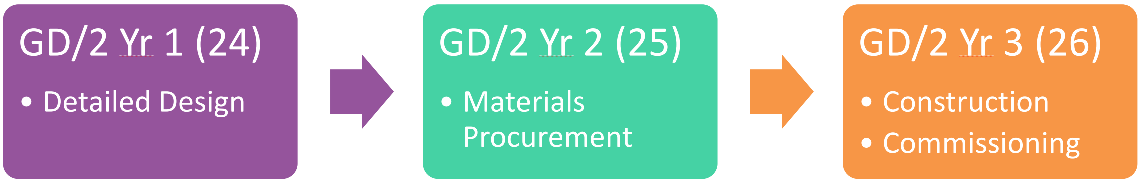
9.1 Preferred option

The preferred option for Shatterling PRS is to replace the sites existing pre-heating system with two heat exchangers, new connecting pipework, a boiler house with multiple gas fired, condensing boilers, with stand by capacity.

9.2 Asset Health Spend Profile

The anticipated asset spend profile is as follows:

Asset Health Spend Profile (£m)						
	2021/22	2022/23	2023/24	2024/25	2025/26	Post GD2
Preheater Replacement	0.00	0.00	0.17	0.47	0.79	0

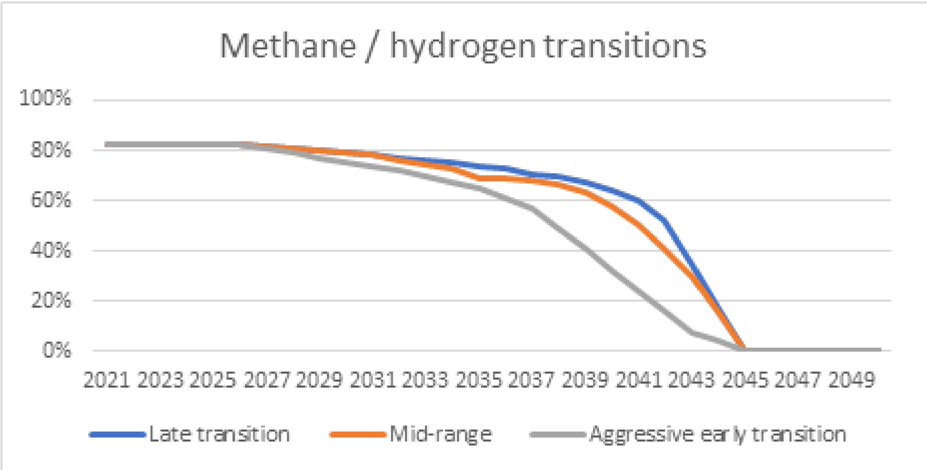


9.3 Investment Risk Discussion

Sensitivities have been applied to the Transmission Integrity CBAs as follows:

- Variations in Capex project cost have been applied for the range -10% to +20%. These are considered realistic ranges based on our experience in GD1 and the likely pressures on cost in relation to the procurement of materials and main contracts.
- Variations in methane levels (and therefore environmental impact) have been considered to take account of the anticipated introduction of hydrogen. SGN have committed to a 'net zero' carbon network by 2045. In practice that means no methane by that date. Also, while the use of hydrogen in distribution is being actively investigated and hydrogen is currently being introduced into a network for the first time since the conversion to natural gas, it is considered very unlikely that hydrogen will be injected on a wider scale until RIIO-GD3. For these reasons, methane levels have been considered in three ranges: aggressive early transition, mid-case and late transition.

Methane / hydrogen transition – sensitivities



The current version of the CBA template, version 4, already acknowledges that methane is estimated to be 28 times more damaging than CO_2. This figure is taken from the IPCC Fifth Assessment Report published in 2014. Since this figure is derived from the latest science, it is not considered prudent to test for sensitivity in this area.

Sensitivity in the value / cost of carbon is already included within the CBA template with base-case and high-case scenarios mapped out. These sensitivities are considered sufficient in our CBA.

	Low	Mid	High
GD2 Capex (£m)	1.29	1.43	1.72
Number of Interventions	0	0	0
Carbon Savings ktCO2e (GD2)	272	272	272
Carbon Savings ktCO2e /yr	54	54	54
Carbon Emission Savings (35yr PV, £m)	0.4	0.4	0.4
Other Environmental Savings (35yr PV, £m)	0	0	0
Safety Benefits (35yr PV, £m)	4.9	4.9	4.9
Other Benefits (35yr PV, £m)	0.0	0.0	0.0
Direct Costs (35yr PV, £m)	-1.1	-1.3	-1.6
NPV (35yr PV, £m)	4.1	4.0	3.7

Project payback has not been carried out as part of this analysis due to the effect of the Spackman approach. For a cash-flow traditional project payback period please see scenario 4 of our Capitalisation Sensitivity table.

Capitalisation Sensitivity

Consumers fund our Totex in two ways – opex is charged immediately though bills (fast money – no capitalisation) and capex / repex is funded by bills over 45 years (slow money – 100% capitalisation). The amount deferred over 45 years represents the capitalisation rate. Traditionally in 'project' CBA's the cashflows are shown as they are incurred (with the investment up front which essentially is a zero capitalisation rate). Therefore, we have developed scenarios that reflect both ways of looking at the investment – from a consumer and a 'project'.

The scenarios are summarised as follows:

Scenario 1 - we have used the blended average of 65%, used in previous iterations of this analysis.

Scenario 2 - we have represented the Capex and Opex blend for the two networks, as per guidance.

Scenario 3 - addresses our concerns on capitalisation rates whereby Repex and Capex spend is deferred (100% capitalisation rate) and Opex is paid for upfront (0% capitalisation rate).

Scenario 4 - this reflects the payback period in 'project' / cash-flow terms and provides a project payback.

We have taken a view of the NPV in each of the scenarios, with the exception of scenario 4, at the 20, 35 and 45 Year points, to demonstrate the effect of Capitalisation Rate on this value.

Scenario	1	2	3	4
Capex (%)	65	38	100	0
Opex (%)	65	38	0	0
Repex (%)	100	100	100	0
Output				
NPV (20yr PV, £m)	1.42	1.37	1.65	
NPV (35yr PV, £m)	3.94	3.95	4.07	
NPV (45yr PV, £m)	5.31	5.32	5.39	
Payback	13.00	13.00	9.00	14.00

Capitalisation Rate Sensitivity

Appendix A - Acronyms

Acronym	Description
BarG	Measurement of pressure above atmospheric pressure (gauge) in units of Bar
CBA	Cost Benefit Analysis
CGS	City Gate Station – A pressure reduction system supplied from the intermediate pressure system and feeding either low or medium pressure systems
DS	Downstream
GD1	Gas Distribution – Price Control for 2013 to 2021
GD2	Gas Distribution – Price Control for 2021 to 2026
HAZOP	Hazard and Operability Study
HI4	Health Index – Asset condition approaching or at end of serviceable life, intervention required
HP	High Pressure (Natural Gas above 7 barg)
IGEM	Institution of Gas Engineers and Managers
IP	Intermediate Pressure (Natural gas 2 barg to 7 barg)
KPI	Key Performance Indicator
LTS	Local Transmission System
LP	Low Pressure (Natural gas less than 75 mbarg)
MP	Medium Pressure (Natural Gas 75 mbarg up to 2 barg)
NARM	Network Asset Risk Measure
PE	Polyethylene
PoC	Probability of Consequence
PRI	Pressure Reducing Installation
PRS	Pressure Reduction Station
PSSR	Pressure Systems Safety Regulations 2000
RIIO	Revenue = Incentives + Innovation + Outputs
Scm/h	Standard cubic metres per hour (Flow)
TD/13	IGEM/TD/13, Pressure regulating installations for natural gas, liquefied petroleum gas and liquefied petroleum gas/air
µm	Micron, Micrometre = one-millionth of a meter
WBH	Water Bath Heater

Appendix B - References

Commercial Confidentiality, Security