Engineering Justification Paper

Telemetry Refresh

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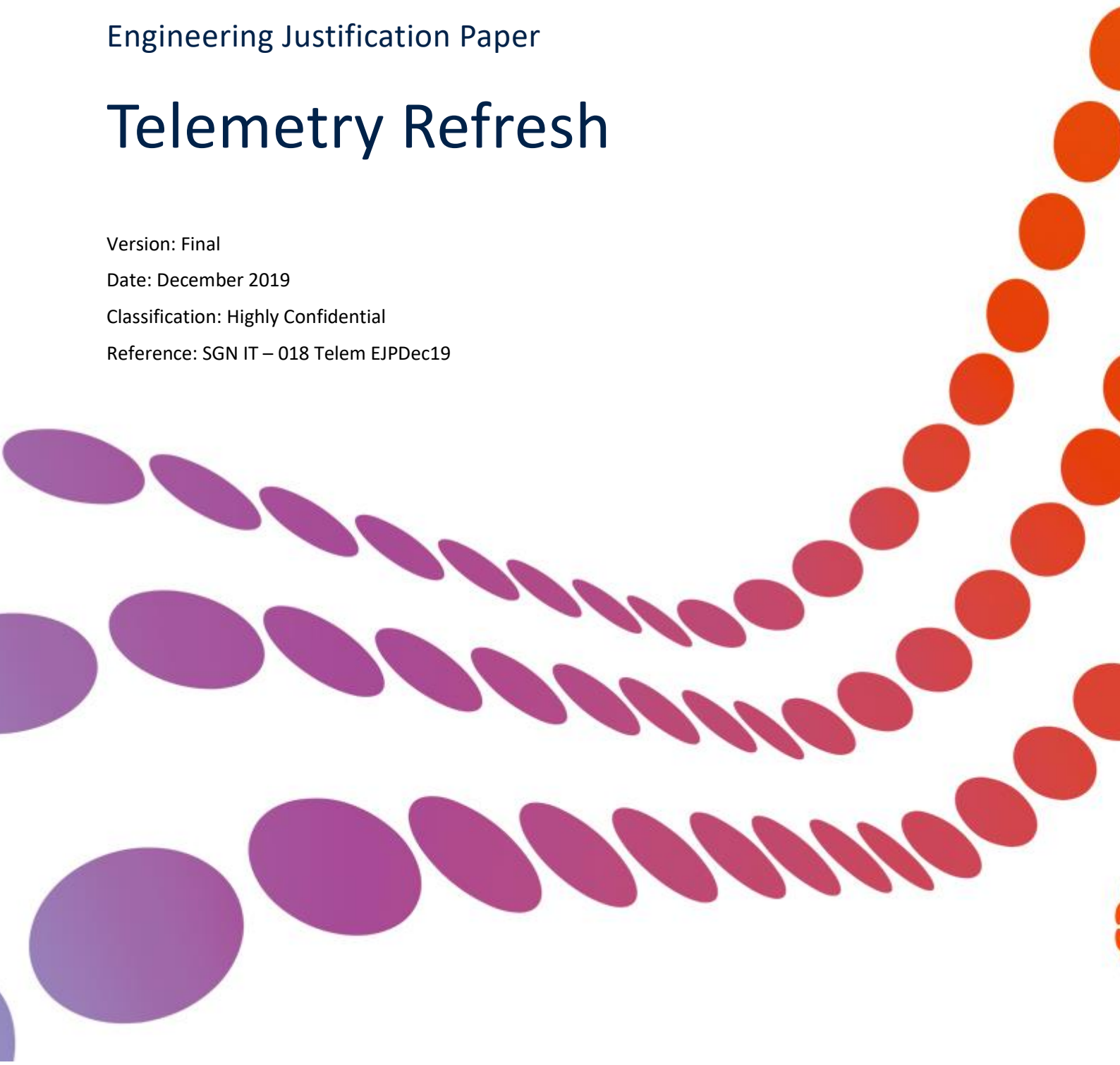


1 Table of Contents

2 Introduction

SGN's Gas Control Centre receive telemetered data from Security to enable them to monitor and control SGN's Gas Distribution Network. This remote control and monitoring is achieved using a dedicated communications network that connects the remote sites into the Gas Control SCADA (Supervisory Control and Data Acquisition) systems located at Security This communications network is depicted at a high level in Figure 1 below.

The current telemetry network was brought under SGN's direct control when it was migrated from National Grid in 2011. There has been no investment in the system, apart from fault-fixing and network expansion since that time. Parts of the system, the Security

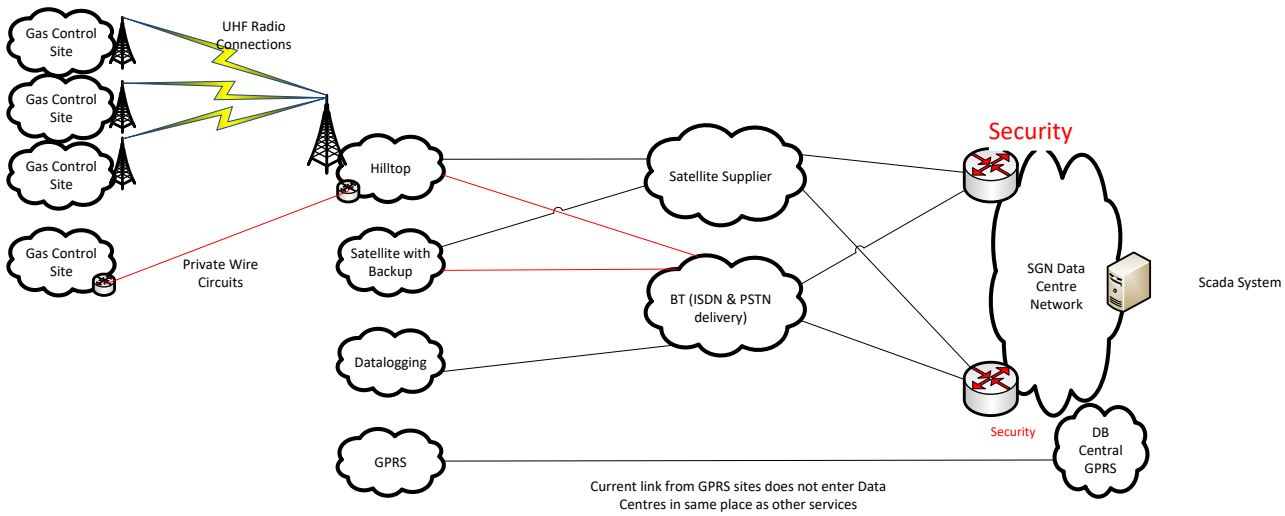
Many of the components that are used to support this system have already, or will within the GD2 period, be Security

Over the last 8 years there has been a steady increase in the number of communications related faults and increased levels of service interruption.

This project seeks to address these issues by replacing/upgrading the existing communications network, with the exception of the existing satellite infrastructure.

This paper needs to be reviewed in conjunction with EJP – Control Room (*SGN IT - 005 ContRm EJPDec19*), EJP – RTU Refresh (*SGN E&I - 001 Tele - EJP Dec19*), EJP – Cyber Security (*SGN IT - 007 Cyber - CBADec19*).

Figure 1: SGN Telemetry Network – High Level View



2.1 General Background

Gas Control receive telemetered data from Security to enable them to use their critical SCADA (Supervisory Control and Data Acquisition) System to monitor and Control SGN's Gas Distribution Network.

SGN's SCADA system monitors the mechanical systems on gas sites to ensure that if there are any issues with the equipment, staff can be despatched to the site to correct the issues. The loss of the telemetry network would remove SGN's capability to monitor the state of the on-site equipment.

The pressure readings sent from site on the high-pressure network allow SGN to calculate the storage held within the network and subsequently allow SGN to forecast the demand on each LDZ as per the UNC obligations.

The telemetered data may also be used in the future to support predictive analytics provided by the Real Time Networks project.

SGN's regulatory obligation around measuring gas quality, composition and LGT are also enabled by Telemetry.

The existing satellite and UHF radio communications network has several issues:

- Security

- Increased service outages due to end of life/end of support devices failing
- Costs which are outside SGN's control when accessing sites for maintenance and ongoing operation
- Security issues at Security , as SGN have limited control over access to these sites
- Some gas sites are utilising old, or out of contract services (iSDN, PSTN, Private wires). B.T. have given notice that these copper based services will be retired by 2025
- Benefits of newer technology (both in price and capabilities) are being missed
- Existing equipment such as master and remote radios have become obsolete, and are no longer supported by the manufacturers
- Security

- Radio antennas and satellite masts have not been replaced since the service was created by National Grid in 2000

2.2 Site Specific Background

SGN's gas telemetered sites were inherited from National grid prior and they are in Scotland, South and South East of England. Please see section 3.1 for site quantities including information of their criticality.

3 Equipment Summary

3.1 Site Tiers

At present, the site types within the Gas Telemetry network are divided into 4 "Tiers" of criticality, these are described below.

Table 1: Communication Media by Site Type

SGN INE/2 Category	Current Telemetry Method	Approximate Number of Gas Sites	Notes
Tier 1	Satellite and Backup (ISDN or PSTN)	65	These critical sites include Hilltops / Offtakes / Biogas Sites with two forms of communication.
Tier 2	Satellite	72	These sites have only one form of communication.
	UHF Radio via 22 Hilltop radio sites	199	
	Private Wire via 3 Hilltop radio sites	3	
Tier 3	GPRS	11	These sites are non-critical sites where telemetry from the sites can be collected on a less frequent basis.
Tier 4	PSTN Datalogger Sites	45	These sites are monitored on an infrequent basis only.

3.2 Technology Components

The current technology connecting the Gas Control sites via the Telemetry Network has been developed over many years, and two in particular are now being withdrawn from service.

ISDN & PSTN – BT are withdrawing these products by 2025, as all their exchanges will be solely IP capable by that date, and ISDN and PSTN are not IP products.

Private Wires – These low capacity (sub 2Mb/s), circuits will no longer be supported by BT after March 2020. SGN have invested in replacing these private wire kilostream circuits within the GD1 period.

Other technologies that are being used include

Satellite – this is a tried and tested technology that has worked for SGN within the GD1 period.

UHF Radio – SGN lease (from JRC) radio frequencies for communicating with some sites. This is using old equipment, and has been susceptible to atmospheric conditions in the past. Trials have been conducted with an alternative 4RF technology and further trails are planned with Long Range Radio within the GD1 period. Based on the outcome of the trial SGN will be investing in a replacement or upgrade.

Security

This is being reviewed by BEIS and SGN and have raised a risk on the company risk register; such outages require the sites to be visited daily.

Routers – Sites with backup links Security to link to other sites have routers on site. Some of these have now been classed as end of life, meaning that in the next 5 years, the routers will be on a reduced level of support, and by 2022, will no longer be supported by them.

Hubs – It is believed the hubs installed on site when the telemetry function was transferred from National Grid have been replaced by Security that are managed and supported. Any solution would have to work with these switches that remain in support with Cisco.

4 Problem Statement

The Gas Control Telemetry Communications Network continues to operate but with a growing number of faults and an increasing risk of operational disruption as the communications infrastructure ages and spare parts are more difficult to source. The Communications Network is becoming more susceptible to interference as seen by major outages in 2016. This is leading to increased operational expenditure and a greater likelihood of disruption.

Why are we doing this work and what happens if we do nothing?

The incidence of failures is on an upward trend. If the obsolescence is not addressed the telemetry network will no longer remain fit for purpose. The loss of visibility will mean for periods of black outs, it will be harder for SGN to meet its license obligations.

What is the outcome that we want to achieve?

During RIIO GD1, SGN undertook an independent review of its telemetry problems, followed by technology trials. Strategic recommendations were made as an output of these two phases of the refresh project. SGN would like to use this investment to complete the refresh of its telemetry network, to achieve the following objectives:

- Address Obsolescence with minimal impact to operation and without fully realizing the benefits from invested assets. It is vital that any solution to replace the services being withdrawn can run alongside the old technology.
- Fit for purpose. There can be no “big bang” replacement of the network, it must be achieved over a period of time, on a site by site basis.
- Improve service resilience against weather events.
- Future-proof: Support for IIOT devices, secure protocols and modern data traffic management.

How will we understand if the spend has been successful?

The following critical success criteria will be used to measure the success of this refresh:

- Tier 1 site backup links, Tier 2 site and Tier 3 gas sites (currently 308 sites) telemetry refreshed with the selected option. If the site numbers change, there will be corresponding change in the installation and support costs
- Reduction in telemetry faults
- Support for new IIOT devices and sensors with the core infrastructure made available

4.1 Narrative Real-Life Example of Problem

SGN performed a risk analysis in June 2019, because of which, the highest risk issues like Kilo stream Circuits are planned to be addressed within the GD1 period.

Risk	When	Issue	Solution

Security

However, the residual risks which need to be addressed within the GD2 period are marked below:

Risk	System	Issue	Dates	Effects	Resolution	RAG		
No.						**Impact**	**Likelihood**	**Consequences**

Security

Security

Security

Security

4.2 Spend Boundaries

It must be noted that the replacement telemetry solution and its ability to insulate against weather events will be limited by the technology available at the time of this investment.

This refresh programme needs to be mindful of the current and new demands from SCADA or site equipment like Remote Telemetry Units / IIOT devices. However, the investment in functionality at SCADA end or modernising equipment at site are considered outside the scope of this paper.

This paper needs to be reviewed in conjunction with EJP – Control Room (*SGN IT - 005 ContRm EJPDec19*), EJP – RTU Refresh (*SGN E&I - 001 Tele - EJP Dec19*), EJP – Cyber Security (*SGN IT - 007 Cyber - CBADec19*).

5 Probability of Failure

The telemetry services are not built to fail to ensure continued 24x7 service. Each site tier and the level of resilience is built and defined as per the Telemetry Policy INE2. Each failure occurrence is dealt with as an emergency with resolutions targeted within minutes and hours, rather than days. This level of service has been expected throughout the GD1 period and will be expected at the same, if not improved, in the GD2 period as well.

5.1 Probability of Failure Data Assurance

For this paper, Network assets are assumed to have a relatively short life of 5 years*, as against hardware components like RTUs.

Ref: Network equipment Life benchmark from a comparable Australian utility asset management plan
https://www.aer.gov.au/system/files/PWC%20-%2014.9P%20AMP%20SCADA%20and%20Communications%20-%2028%20February%202018.pdf

6 Consequence of Failure

Table 2: Impact of Failure

Failure Categories	Loss of Supply to Customers	Safety Impact of Failure	Effects on SGN's normal business operations	Environmental Impact
Security				

Security

Security

7 Options Considered

7.1 Option 1 - Replace the current telemetry and migrate the services

SGN anticipates the technology trials of replacement solutions to be concluded in GD1. A framework of telemetry connectivity options will be developed with specific recommendations made available for new sites.

This option will pre-emptively replace the telemetry connectivity in a phased manner for the existing sites from Year 1 in the GD2 period.

The costs for Phase 2 will be spread over 3 years directly proportional to the number of sites rolled over to the new communication link(s). The cost to decommissioning old radio equipment is also included in the proposed capex.

The costs are based on cost estimates provided from vendors like British Telecoms (BT), Vodafone and Arqiva.

7.2 Baseline Option – Do nothing and replace on failure

Telemetry will continue to operate with increased number of faults and a corresponding increase in the risk of operational disruption, as well as increased operational expenditure to react to faults. It will also be more difficult and costly to get spares and support as equipment is already or going to be out of support in the next 3 years.

The system will still be subject to significant widespread and unplanned outages caused by tropospheric interference. These outages will continue to be highly demanding in terms of necessitating regular site visits to a significant number of gas sites.

7.3 Options Technical Summary Table

Table 3: Options Technical Summary

Option	First Year of Spend	Final Year of Spend	Volume of Interventions	Equipment / Investment Design Life	Total Cost
Commercial Confidentiality Security					

Please note the costs outlined in the Options Technical Summary Table are based on the following assumptions:

Baseline Assumptions:

- SGN manage its IT estate in line with the HSEs ALARP (as low as reasonably practicable) risk management principles. On that basis SGN have assumed a failure to invest in required upgrade, replacement or refresh activity for safety critical systems, would lead to catastrophic system failure as well as a lack of 3rd party support (based on support contracts, 3rd party roadmaps, architectural standards and internal policies, designed to ensure upgrade, replacement or refresh activity is carried out at the appropriate point in time to in order to prevent a non-recoverable functional, technical or security failure).
- SGN have assumed that a lack of investment combined with a lack of support would prevent the reinstatement of systems should they fail.
- SGN have assumed a catastrophic failure of safety critical systems and an inability to reinstate systems after failure would lead to an inability to respond to gas emergencies, an inability to know where our assets are and an inability to track performance and regulatory outputs.
- SGN have assumed an inability to respond to gas emergencies, an inability to know where our assets are and an inability to track performance and regulatory outputs would inevitably lead to a catastrophic incident e.g. explosion and loss of life (£17.73m). This assumption is supported by section 2 of the Health and Safety at work act which identifies scenarios that would result in loss of life.
- SGN have assumed an inability to respond to gas emergencies, an inability to know where our assets are and an inability to track performance and regulatory outputs would inevitably lead to an inability to operate. This would lead to a catastrophic breach of license conditions (up to £100m fine)
- SGN have assumed catastrophic failures in regard to loss of life (£17.73m), a breach of license conditions (up to £100m) will occur within 4 years of failing to adhere to support contracts, 3rd party roadmaps, architectural standards and internal policies designed to ensure upgrade, replacement or refresh activity is carried out at the appropriate point in time to in order to prevent a non-recoverable functional, technical or security failure.

Refresh of Telemetry Comms Network Assumptions:

- The planning and tender phase is completed within the GD1 period.
- The phased approach (below) is achievable by the chosen supplier/suppliers:
  - Security
  - Security
  - Security
- SGN can met the resource requirements to support the chosen rollout:
  - Security
  - Security
  - Security
- No increase in costs due to inflation or changes in the exchange rate.
- No catastrophic failures in the existing estate which may require re-assessment of the replacement plan.
- A total of Security sites will be refreshed as part of this project.
- The existing satellite solution will not be replaced.
- Commercially available products are suitable from a power resilience and security perspective in line with the requirements laid down by the industry wide Strategic Telemetry Group hosted by the Energy Networks Association.
- Investing in the replacement telemetry network will reduce the number of outages related to failure of the telemetry communications network which will in turn reduce the number of

site visits required to manage the gas network thus allowing SGN to meet its licence obligations.

- The asset life of any replacement telemetry comms equipment will be 5 years which is in-line with current expectations of network related hardware.

7.4 Options Cost Summary Table

Table 4: Cost Summary

Option	Template	Cost Breakdown	Total Cost (£m)
Refresh of Telemetry Comms Network	IT Capex	Resources Software Hardware Contingency	Commercial Confidentialit
		Total	**2.00**

8 Business Case Outline and Discussion

This investment enables our Gas Control Telemetry communication systems to remain operational. By performing the preferred option 1 i.e. incremental replacement of the soon to be End of Life legacy systems, we can ensure that our DNCS SCADA and dependent systems are operational, thus enabling us to monitor and control the >7 bar gas network. Without these systems, SGN would easily breach the UNC processes thus resulting in loss of license, and fatality.

8.1 Key Business Case Drivers Description

Table 5: Summary of Key Value Drivers

Option No.	Desc. of Option	Key Value Driver
1	**Refresh of Telemetry Comms Network**	Ability for SGN to support business processes Enables us to meet our outputs and license conditions Incremental change to address obsolescence
2	Do nothing	Not recommended

Table 6: 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	Do Nothing / Do minimum	N	0.00	-117.73	-117.73	-117.73	-117.73	-117.73
1	Refresh of Telemetry **Absolute NPV**	Y	-2.00	-9.80	-2.61	-3.87	-5.04	-7.03
1	Refresh of Telemetry **NPV relative to Baseline**	Y	-2.00	-9.80	**115.12**	**113.86**	**112.69**	**110.69**

8.2 Business Case Summary

Table 7: Business Case Matrix

	Refresh of Telemetry Comms Network
GD2 Capex (£m)	2.00
Number of Interventions	308.00
Carbon Savings ktCO2e (GD2)	0.00
Carbon Savings ktCO2e /yr	0.00
Carbon Emission Savings (35yr PV, £m)	0.00
Other Environmental Savings (35yr PV, £m)	0.00
Safety Benefits (35yr PV, £m)	17.73
Other Benefits (35yr PV, £m)	100.00
Direct Costs (35yr PV, £m)	-7.93
NPV (35yr PV, £m)	109.80
High Carbon Scenario	
Carbon Emission Savings (35yr PV, £m)	0.00
High Carbon NPV (35yr PV, £m)	109.80

9 Preferred Option Scope and Project Plan

9.1 Preferred option

The preferred option 1 is to replace the current telemetry and migrate the soon to be end of life services. This is the lower risk, lower investment option.

9.2 Asset Health Spend Profile

It is anticipated that the replacement of the sites will be phased and span approximately 3 years given resource and technical constraints. Any funding, tests and contracts will be placed before the GD1 period closes, in anticipation of this funding approval.

Figure 2: High level plan

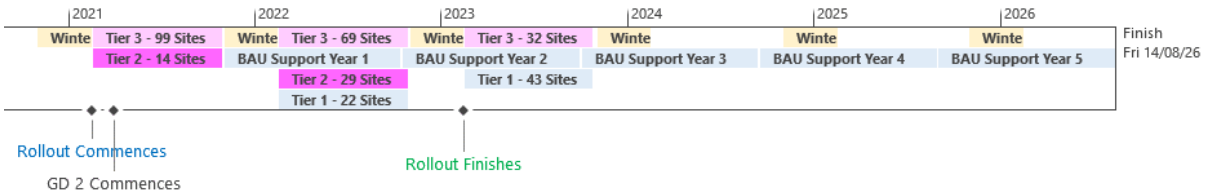


Table 8: Asset Health Spend Profile

Asset Health Spend Profile (£m)						
	2021/22	2022/23	2023/24	2024/25	2025/26	Post GD2
Refresh of Telemetry Comms Network	1.00	0.50	0.50	0.00	0.00	18.0

9.3 Investment Risk Discussion

Table 9: Keys Risks

Risk Description	Impact	Likelihood	Mitigation/Controls	Comments
Increase in capex expenditure	Capex expenditure	>80% & <=100%	This work will be subject to a tender process - running this process will help clarify the costs associated with replacement.	Original costs were only ROM costs and didn't include replacement of the satellite network, cost of replacing ageing satellite dishes many of which are between 8 and 20 years old, costs of replacing radio antennas many of which are between 8 and 20 years old. in addition, costs for staff /contractors will increase.
Increase in scope	Capex expenditure	>80% & <=100%	This work will be subject to a tender process - running this process will help clarify the costs associated with replacement.	The existing satellite network is also in need of replacing as various parts are also end of life.
Increase in timescales	Capex expenditure	>40% & <=60%	This work will be subject to a tender process - running this process will help clarify the costs associated with replacement.	Initial 3-year estimate didn't cover replacing of the core satellite network.
Increase in capex expenditure	Capex expenditure	>40% & <=60%	Full risk assessment of chosen technologies. Deploy multiple technologies from different providers.	Current satellite and radio networks are private and only carry SCADA traffic.
Increase in capex expenditure	Capex expenditure	<=20%	Ensure technologies chosen have the longest possible support period.	Low risk.
Increase in capex expenditure	Capex expenditure	>80% & <=100%	Look at deployment of multiple solutions rather than one single solution.	There are sites where we have known communication issues.
Increase in capex expenditure	Capex expenditure	>40% & <=60%	Ensure overarching technical strategy is set.	

Table 10: Sensitivity Results for the Preferred Option

	Low	Mid	High
GD2 Capex (£m)	1.80	2.00	3.00
Number of Interventions	308	308	308
Carbon Savings ktCO2e (GD2)	-	-	-
Carbon Savings ktCO2e /yr	0	0	0
Carbon Emission Savings (35yr PV, £m)	0.0	0.0	0.0
Other Environmental Savings (35yr PV, £m)	0	0	0
Safety Benefits (35yr PV, £m)	3.5	17.7	17.7
Other Benefits (35yr PV, £m)	20.0	100.0	100.0
Direct Costs (35yr PV, £m)	-7.1	-7.9	-11.9
NPV (35yr PV, £m)	16.4	109.8	105.8

SGN IT believes the preferred option is refresh the existing Gas Control Telemetry Communications Network (with the exception of the satellite infrastructure. For the purpose of sensitivity analysis, the following has been applied to the preferred option:

Low Case: SGN have applied a reduction of 10% CAPEX costs – this can be applied if SGN achieve greater than expected discounts on material purchase and also if greater efficiencies can be achieved in projects delivery that haven't already been fed into the costs – this would be process improvements and streamlining working practices to reduce mobilisation time on site. Furthermore, an 80% reduction has been applied to the Safety Benefits associated with the risk of a fatality and Other Benefits associated with the impact of a Breach of Licence Conditions.

Mid Case: no changes have been applied, this is the expected output required for the GD2 time period.

High Case: SGN have applied an additional 50% on the CAPEX expenditure, as this is believed to be the potential cost increase if SGN do go to tender but do not achieve the indicative costs outlined in this paper. This could also be impacted by political changes which may impact on resource availability, material costs or changes in the labour market. This increase in cost also allows for any additional spend associated with a potential replacement of the satellite infrastructure.

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, except for scenario 4, at the 20, 35 and 45 Year points, to demonstrate the effect of Capitalisation Rate on this value.

Table 11: Capitalisation Rate Sensitivity Results

Scenario	1	2 SGN	3	4
Capex (%)	65	41	100	0
Opex (%)	65	41	0	0
Repex (%)	100	100	100	0
Output				
NPV (20yr PV, £m)	113.18	112.59	114.04	
NPV (35yr PV, £m)	110.21	109.80	110.82	
NPV (45yr PV, £m)	108.75	108.46	109.18	
Payback	3.00	3.00	3.00	3.00

Appendix A - Acronyms

Acronym	Description
Arqiva	Arqiva is a British telecommunications company which provides infrastructure and broadcast transmission facilities in the United Kingdom
BEIS	The Department for Business, Energy and Industrial Strategy is a department of the government of the United Kingdom
BGAN	The Broadband Global Area Network (BGAN) is a global satellite network with telephony using portable terminals
BT	BT Group plc is a British multinational telecommunication holding company headquartered in London, United Kingdom
CBA	Cost Benefit Analysis
CNI	Critical National Infrastructure
DNCS	Distribution Network Control System
EJP	Engineering Justification Proposal
GPRS	General Packet Radio Service is a packet oriented mobile data standard on the 2G and 3G cellular communication network's global system for mobile communications
H&SE/HSE	Health and Safety Executive
HPMIS	High Pressure Metering Information System
IIOT	Industrial Internet of Things
IP	Internet Protocol
ISDN	Integrated Services Digital Network is a set of communication standards for simultaneous digital transmission of voice, video, data, and other network services over the traditional circuits of the public switched telephone network
IT	Information Technology
JRC	The Joint Radio Company Ltd. (JRC) is an Industry-Owned Spectrum Management Consultancy and Spectrum Management Organisation
LDZ	Local Distribution Zone
LGT	Local Gas Treatment
MDS Radio	MDS is a world leading single-source, end-to-end industrial wireless communications provider
NG	National Grid
NPV	Net Present Value
OCC	Operational Control Centre
PSTN	The public switched telephone network is the aggregate of the world's circuit-switched telephone networks that are operated by national, regional, or local telephony operators, providing infrastructure and services for public telecommunication
RAG	Red Amber Green
ROM	Rough order of magnitude
RTU	Remote telemetry unit
SCADA	Supervisory control and data acquisition

SE LDZ	South East LDZ
SGN	Scotia Gas Networks
SGN/PM/INE/2	SGN policy that defines telemetry standards
THPC	Transco Hilltop Protocol Converter
UHF	UHF radios (Ultra High Frequency) operate on frequencies ranging from 400-512 Megahertz (MHz). UHF radios work best for most two-way radio users because the waves are shorter and can get around or penetrate areas of interference, like those found in buildings, thickly wooded or hilly areas, and urban outdoor settings
UNC	Unified Network Code