RIIO GD2 Business Plan Appendix

Electrical and Instrumentation

December 2019

SGN
Your gas. Our network.

www.sgn.co.uk

Contents

1 Overview

Joint Office

of Gas Transporters

Scope of this appendix

The Network Electrical & Instrumentation (E&I) GD2 appendix covers each programme of work or stand-alone project proposed to be undertaken in the GD2 price control of RIIO. Within the current GD2 E&I business plan there are no proposals to invest in new asset groups. For greater detail of the background and technical evidence, this report is supported by a project appendix. This investment proposal promotes a safe and reliable network that will lead to continued safety management by reducing this risk of failure in gas processing, monitoring systems and fault reporting, while also helping to generate operational benefits through a streamlined plan of works for GD2.

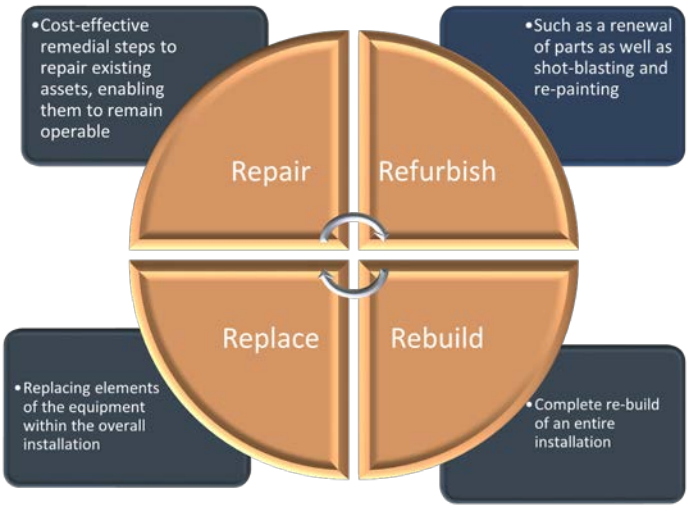
This appendix covers the E&I assets of the transmission pipeline, it is closely aligned with the Transmission Integrity Appendix [021] that covers the mechanical aspects of the transmission network and with the IT & Cyber Resilience Appendix [011] which covers some of the infrastructure requirements.

Impact

The gas that we transport is a hazardous substance, but while it is retained within the pipe, it is safe. Effective instrumentation, monitoring and measurement is key to maintaining visibility and control of critical assets to avoid an escape. Our customers and stakeholders have told us maintaining current levels of safety is very important to them, reliability is important to them and maintaining a safe and reliable network should be our priority for RIIO-GD2. This customer expectation is supported by a strong legislative and regulatory framework that provides clear focus on when we should intervene. These are then supported by internal procedures that set out how we should act.

1.1 Approach to GD2

We are proposing a business plan that minimises capital investment to levels required to maintain our license and core safety obligations. Throughout GD1 our approach to E&I asset investment was determined according to our 4Rs (Repair, Replace, Refurbish, Rebuild) strategy, designed and used to identify the most appropriate action. Therefore, as before we have adopted and will apply the 4R strategy for GD2 for this Asset Group.



The core of our 4R strategy is focussed around the following systems of work which informs our Asset Health and criticality ratings and priorities.

- Routine Maintenance Process – Asset Maintenance Programme
- Condition Assessments, CM/4 Part 1 (E&I) – Management Procedure for Condition Assessment and Defect Reporting of above 7 Bar Assets
- Fault Monitoring & Analysis
- Asset Health & Criticality Assessments
- Periodic Functional Safety Assessments

Asset groups explained

E&I assets on operational gas sites provide a monitoring and support function for the preheating and flow of natural gas through national offtake sites, Pressure Reduction Stations (PRS) and other more specialised site types, such as Scottish Independent Undertaking's (SIU's), Biomethane Network Entry Facilities (BNEF's) and Cathodic Protection Transformer Rectifier (CPTR) locations.

- **Instrumentation.** Instruments such as temperature and pressure sensors are used to measure the gas temperatures and pressures on site, this data is fed into a telemetry system, and sent remotely to the Gas Control Centre (GCC) where site status is monitored and controlled.
- **Telemetry.** Information such as gas pressure, temperature, flows and gas quality are fed back to GCC via remote telemetry units. On some sites within SGN, temperature control is managed within the remote telemetry units as opposed to an independent temperature controller.
- **Pre-heating.** Gas pre-heating systems rely on gas temperature data provided by site instrumentation. Sites within SGN which are pre-heated with boiler systems are supported by standby diesel or gas electrical generators as an added level of redundancy. SGN also have water bath heaters as an alternative method of gas-preheating.
- **Metering.** SGN meter gas flow at national offtakes for fiscal purposes and compliance reasons. These flows are

fed back to GCC via the remote telemetry unit. We have also been moving away from orifice plate metering to ultra-sonic metering which provides more accurate readings with fewer errors and improved uncertainty of measurement. Metering is also crucial for correct odorant injection into the gas network. We also provide metering for inter LDZ sites.

- **Gas quality.** Gas quality is measured at national offtake sites for regulatory/compliance purposes. This is done using an instrument called a gas chromatograph.
- **Local gas treatment.** At national offtakes, we odorise natural gas. This is a health and safety and compliance requirement. The odorising equipment consists of an electronic controller as well as level gauges, pumps and motors. The volume of odorisation which is injected into the gas is determined by the gas flow rate. This is calculated within the controller using the data from the site flow metering.
- **Electrical distribution.** All of the above-mentioned assets require an electrical supply, as well as other site assets such as site alarms, interior lighting, flood lighting, security fence systems and space heating.

For the GD2 price control period the projected expenditure for E&I is set out in the table below. For the GD1 price control the E&I figures in Table 1 are for illustration purposes only and these costs have been included in the Transmission Integrity appendix 021, as such they are not additional.

The annual costs for GD2 are higher as the spend is spread over a shorter period, however with similar workload. Network E&I have also identified additional workload not covered in GD1 to meet compliance obligations.

1.2 Forecast investment

Table 1: RIIO-GD2 Electrical and Instrumentation Investment Proposal.[1]

SGN (£m)	13/14	14/15	15/16	16/17	17/18	18/19	19/20	20/21	21/22	22/23	23/24	24/25	25/26
Offtakes	1.4	0.3	0.8	1.2	2.2	5.8	13.9	10.9	4.1	3.1	3.1	3.3	3.6
PRSs	3.9	13.6	23.9	36.6	27.4	29.9	18.7	11.3	4.1	3.8	3.8	4.0	4.3
Total[2]	5.3	13.9	24.7	37.8	29.6	35.7	32.6	22.2	8.2	7.0	7.0	7.2	7.9
Scotland (£m)	**13/14**	**14/15**	**15/16**	**16/17**	**17/18**	**18/19**	**19/20**	**20/21**	**21/22**	**22/23**	**23/24**	**24/25**	**25/26**
Offtakes	1.4	0.2	0.7	1.1	1.2	3.7	6.2	1.1	2.4	1.9	1.9	2.1	2.2
PRSs	1.2	6.9	12.8	14.1	9.0	11.4	5.4	5.8	1.2	1.1	1.1	1.2	1.3
Total[2]	2.6	7.1	13.5	15.2	10.2	15.1	11.6	6.9	3.6	3.0	3.0	3.3	3.5
Southern (£m)	**13/14**	**14/15**	**15/16**	**16/17**	**17/18**	**18/19**	**19/20**	**20/21**	**21/22**	**22/23**	**23/24**	**24/25**	**25/26**
Offtakes	0.0	0.1	0.1	0.1	0.9	2.1	7.6	9.7	1.7	1.2	1.2	1.2	1.4
PRSs	2.6	6.7	11.1	22.5	18.4	18.5	13.2	5.5	2.9	2.7	2.8	2.8	3.0
Total[2]	2.6	6.8	11.2	22.6	19.3	20.6	20.8	15.2	4.6	3.9	4.0	4.0	4.4

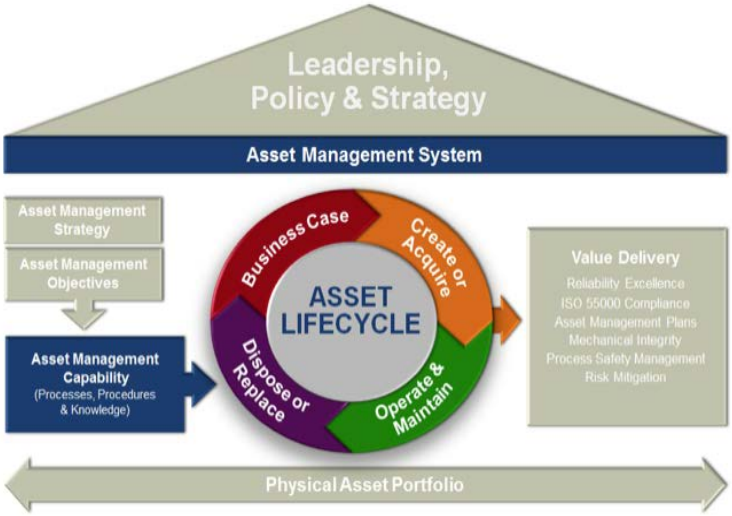
[1] All costs shown are in 2018/2019 prices

[2] Pre-GD2 totals have been taken from Transmission Integrity Appendix 021, where the total figures are provided, which includes pre-GD2 E&I.

1.3 Asset management strategy

In line with our international accreditation on asset management principles ISO55001 and SGN Asset Management Policy, Network E&I is committed to providing a reliable gas supply to our 5.9 million customers, even in the coldest weather conditions when peak gas demand is at its highest levels. We will continue to ensure that the gas network operates safely by understanding, quantifying and managing the risks posed to gas users, the general public and our employees.

This asset management philosophy assists Network E&I to pro-actively manage the lifecycle of our assets, from acquisition to decommission. This framework allows us to manage the risks and costs associated with owning assets, in a structured, efficient manner that supports continual improvement and on-going value creation. In adherence to our SGN Asset Management Policy, Network E&I will,



Ensure compliance by

- maintaining and operating our assets in accordance with our safety case prepared in accordance with the Gas Safety (Management) Regulations and other relevant legislation.
- delivering Ofgem and HSE outputs as part of our licence obligations and legislative requirements.
- planning, designing, installing, inspecting and maintaining our assets in accordance with the Institute of Gas Engineers and Managers recommendations, other industry best practice, Pipelines Safety Regulations and the Pressure Systems Safety Regulations.

Deliver risk management interventions by

- ensuring appropriate risk management in line with our '4R' strategy where SGN will consider a range of possible interventions to manage safety and reliability while having due regard for the current levels of uncertainty. These interventions may include but are not limited to - Repair; Replace; Refurbish; Rebuild.

Manage performance by

- maintaining our ISO55001 certification and striving to continuously improve the management of every asset's lifecycle through effective design and decommissioning, replacing assets that are unreliable, ageing, deteriorating or obsolete to make sure the system remains fit for purpose and safety risks are minimised.
- preparing suitable business plans consistent with our values and this policy to timescales as specified by our economic regulator, Ofgem and the HSE. The financial framework underpinning these plans will allow us to manage the safety and reliability of the gas supply system to the highest standards.
- managing gas flows throughout our networks efficiently to meet demand and within existing energy management constraints in compliance with the Uniform Network Code and supporting documents.

Look after our people by

- providing full technical engineering instruction, training and supervision in the construction, commissioning, operation, inspection and maintenance of operational assets.
- ensuring the best available technical expertise is used to provide guidance and advice to our business.

Work towards a sustainable future

We will encourage and support sustainable options for the provision of gas into the distribution system including biomethane, and the maintenance of operational assets.

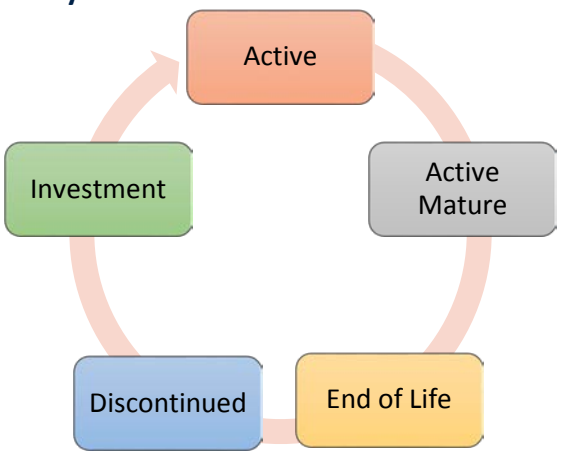
We aim to reduce our carbon footprint from network leakage and reduce or recycle waste from our activities. All our E&I waste electrical and electronic equipment will be disposed of in compliance with relevant legislation such as the WEE Directive via our nominated waste disposal contractor.

Asset lifecycle

Typically, as specified in the HSE Research Report (823) on "Managing Ageing Plant", electrical/electronic, control and instrumentation asset types have a lifecycle of 15 to 20 years. However, some other critical E&I software-based assets generally have a 6 to 10-year supported lifecycle and require continuous investment. These assets are typically reliant on technology for example metering, gas quality and telemetry systems.

This is determined by the rate of advancement in technology, and the rate of efficiencies/speed that can be progressed. Given the speed of development - Moore's law is the observation that the number of transistors in a dense integrated circuit doubles about every two years – and the rate at which technology becomes redundant due to it being surpassed and no longer technically supported.

Figure 1: Typical Electronic Equipment Lifecycle

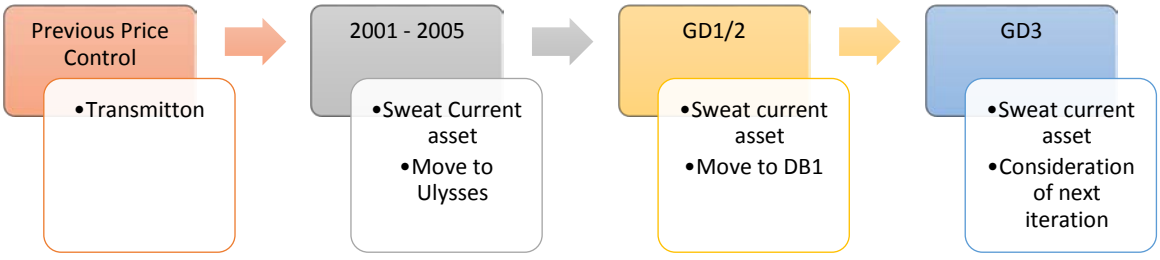


As a result of this continual high rate of advancement, technology such as telemetry, metering and instrumentation can become more advanced, provide more opportunities to collect data, more accurate data and collect data more rapidly. This allows us to work smarter, with better data insights and to improve performance. For example:

- Metering data will be more accurate, reduce the likelihood of metering errors and improve metering uncertainty of measurement. The introduction of this technology will allow for remote diagnostics and reduce site activity and travel.
- Smarter telemetry which will allow for remote diagnostic/resetting of non-critical faults, and better data analysis to determine root cause of faults etc.

This can be demonstrated through the figure below which shows the replacement programme put in place for telemetry in SGN through various price control periods showing the development from Transmitton outstation through to Ulysses outstation, to our current DB1 unit, and then onto the next telemetry asset.

Figure 2: Asset investment strategy for telemetry



The advancement in technology can also provide an opportunity for malicious attacks, such as cyber security

breaches. SGN equipment must continually evolve to ensure security patches are always being supported and upgraded, operating systems are still being supported and that obsolesce, and asset supply chain does not become an issue. An example of this is the Stuxnet virus which affected the control system for a nuclear power plant.

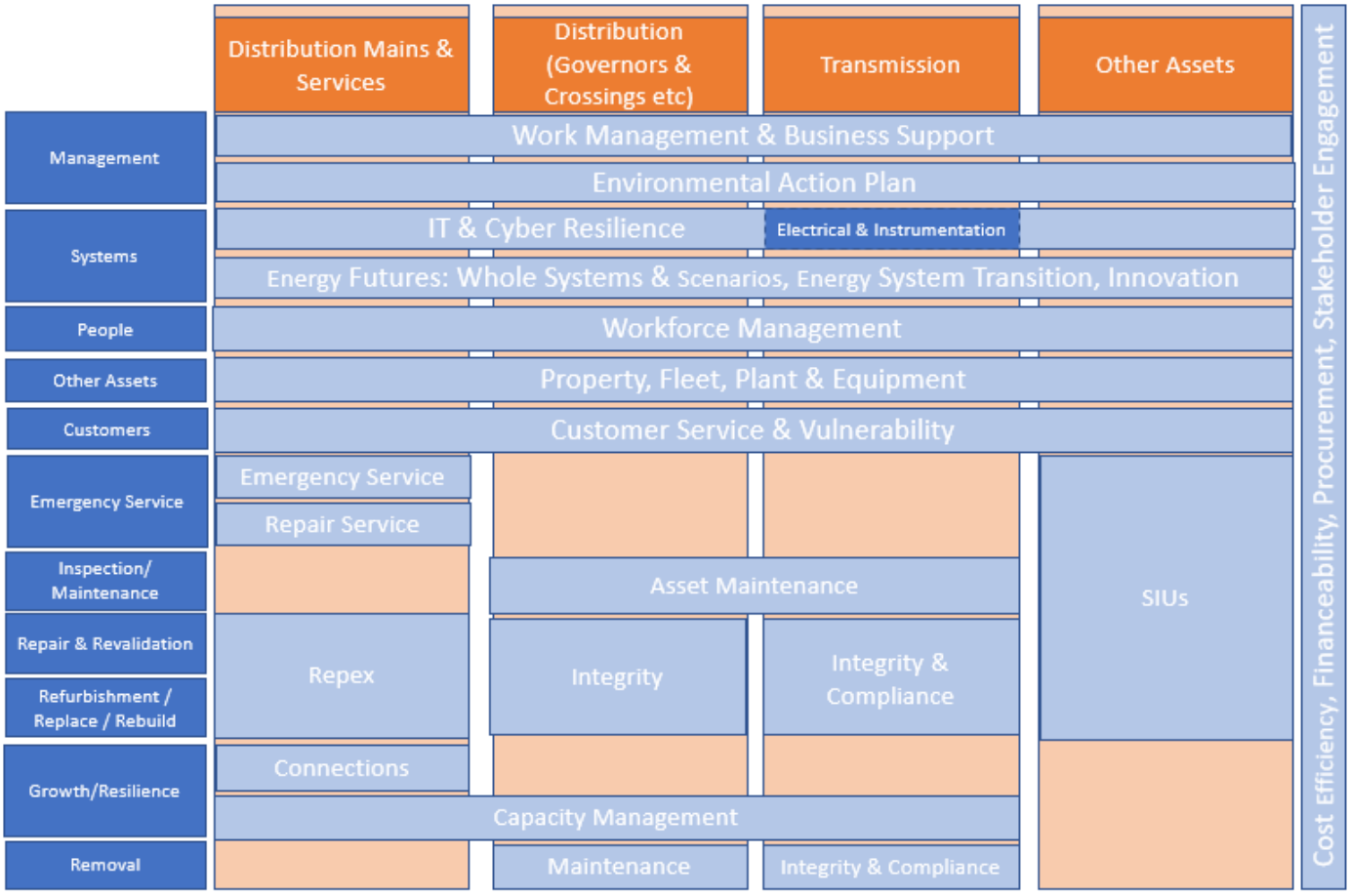
Finally, our control systems must be considered as a whole, as such it is also required to use auxiliary equipment such as connection of laptops/USB drives and other auxiliary equipment to support the diagnostics/repair/update of control systems, and SGN must advance in line with these technologies to ensure systems are being supported. This is further expanded in the IT & Cyber Resilience Appendix [011].

2 Electrical and Instrumentation within the Business Plan

The Electrical and Instrumentation (E&I [002]) appendix provides the background and context for the investments we are proposing to undertake, thereby delivering the appropriate levels of infrastructure to enable our field-based assets to be monitored and assessed effectively.

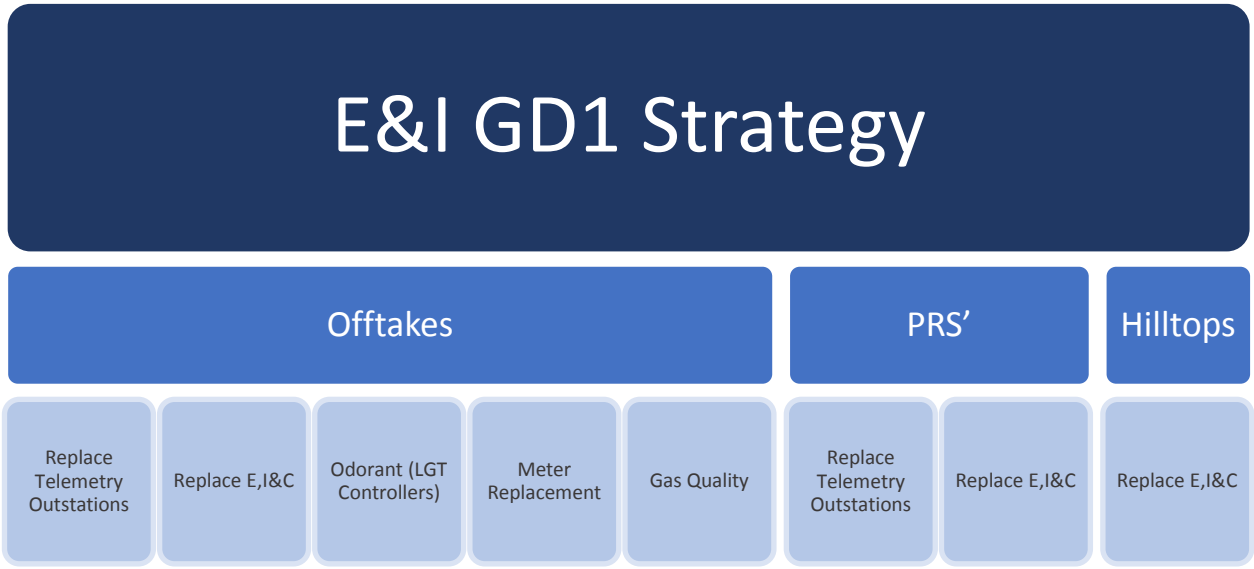
The E&I appendix primarily focusses on assets that are related to the transmission system, due to the size and the importance of this asset group. It also has a strong overlap with the system and the security that is discussed within the IT & Cyber Resilience Appendix [011], and shares many of the same challenges of redundancy, security and additional opportunity. The Cyber resilience around industrial and automation control systems has been covered in the IT Business plan to ensure a consistent approach has been followed across the business. Dataloggers associated with Automated Meter Readings systems installed on SGN Industrial & Commercial sites are also incorporated within this appendix.

Figure 3: Appendix Structure



3 GD1 performance & learnings

3.1 Overview of service delivered



The above overview represents the asset groups and work categories as defined in the GD1 transmission paper - see section 3.5 Table 2 for the detail associated with the GD1 workload. As part of the ongoing asset upgrade strategy for GD1, Network E&I's role is to ensure that the Electrical & Instrumentation (E&I) along with other associated assets are operated, maintained and replaced to ensure a safe and reliable network.

The GD1 work programme was determined according to CM/4 site surveys carried out by asset engineers. Each asset was scored according to condition (CM/4), performance, obsolescence and criticality. E&I asset engineers would also consider key output drivers such as metering requirements to meet fiscal standards and gas quality analysis to meet GS(M)R requirements. These assessments created a prioritisation of sites for delivery in GD1. To deliver these projects E&I asset engineers worked closely with major project engineers to produce scope of works, and project resourcing/delivery plans and mutually agree the most cost effective and efficient delivery plan.

The collaboration between teams was beneficial as it improved the level of communication between all departments and helped reduce issues such as scope creep and remedial works. The continuity of the work programme helped to enable efficient planning and project delivery with resulting costing reductions.

3.2 Legislative background

For E&I activities, the key legislation drivers for compliance of the design, installation, operation and maintenance of the local transmission system operating at pressures above 7barg and up to 85barg pressure are as follows.

Electricity at Work Regulations 1989

The regulations apply to all electrical systems and equipment whenever manufactured, purchased, installed or taken into use even if its manufacture or installation pre-dates the regulations. Where electrical equipment pre-dates the regulations, this does not of itself mean that the continued use of the equipment would be in contravention of the regulations.

It is relevant to all work activities and premises and of particular relevance to duty holders. It will also be of interest and practical help primarily to engineers (including those involved in design, construction, operation or maintenance of electrical systems and equipment), technicians and their managers.

BS7671:2018 – IET Wiring Regulations

The regulations apply to the design, erection and verification of electrical installations, also additions and alterations to existing installations. Installations which conform to the standards laid down are regarded by the HSE as likely to achieve conformity with the relevant parts of the Electricity at Work Regulations 1989.

Dangerous Substances & Explosive Atmosphere Regulations (DSEAR) 2002

The Dangerous Substances and Explosive Atmospheres Regulations 2002 are concerned with protection against risks from fire, explosion and similar events arising from dangerous substances used or present in the workplace and require employers to control the risks to the safety of employees and others from these hazards.

They set minimum requirements for the protection of workers and are goal-setting regulations which are supported by an Approved Code of Practice that provides practical advice on how to comply.

Gas Safety Management Regulations 1996

The Gas Safety (Management) Regulations 1996 (GSMR) apply to the conveyance of natural gas (methane) through pipes to domestic and other consumers and cover four main areas:

- the safe management of gas flow through a network, particularly those parts supplying domestic consumers, and a duty to minimise the risk of a gas supply emergency;
- arrangements for dealing with supply emergencies;
- arrangements for dealing with reported gas escapes and gas incidents;
- gas composition.

Gas Calculation of Thermal Energy Regulations

These regulations provide for the number of therms or kilowatt hours, conveyed by public gas transporters to premises, or to pipeline systems operated by other public gas transporters. They are calculated based on calorific values of the gas (with adjustments of volumes for temperature and pressure) either determined by, or declared by, the transporter in accordance with the regulations. They provide for the places or premises and the times at which and the manner in which determinations of calorific values are to be made to be such as the Director General of Gas Supply ("the Director") may direct. They also provide for declarations of calorific values to be made at such times and in such manner as the Director may direct, for securing uniformity of calorific value and for the carrying out of tests of gas by public gas transporters, and also by persons ("gas examiners") appointed by the Director under section 13 of the Gas Act 1986 at such places or premises as the Director may direct and for such premises, apparatus and equipment to be provided and maintained for carrying out those tests as the Director may direct.

BS EN 61511 – Safety Instrumented Systems for the Process sector

Safety instrumented systems (SIS) are engineered controls that protect critical process systems. The specific control functions performed by a SIS are called Safety Instrumented Functions (SIFs). This standard provides guidance on the specification, design, installation, operation and maintenance of SIF's and related SIS as defined in BSEN61511-1.

It is recognised as good engineering practice in most countries and is a regulatory requirement in an increasing number.

Its use will help assure reliable and effective implementation of SIS to achieve risk reduction objectives, thereby improving process safety.

End users in the process industry should use this standard to develop their internal procedures, work processes, and management systems. Implementing a SIS lifecycle management system provides a framework for managing people, processes, and systems to improve overall safety and operational performance.

3.3 GD1 output delivery

There were no direct high-level E&I outputs listed within the SGN GD1 business plan, although the Ultrasonic Flow Meter Replacement programme was a named project within the GD1 Transmission plan. Some lower level deliverables associated with our transmission system were listed and are currently being delivered as part of the GD1 programme. These are listed in Table 2.

3.4 GD1 customer experience

Due to the nature of E&I and associated activities there was no direct impact on customers apart from ensuring a safe and reliable delivery of gas to the general gas consumer and hence vulnerable customers. Upgrading our metering systems has improved system uncertainties, providing more accurate billing systems for shippers and again indirectly domestic gas consumers.

3.5 GD1 allowances and expenditure

The allowance for E&I was not separately identified or allocated in GD1, the associated E&I allowance was contained within the Transmission submission, which was approximately £28.6m to deliver the Electrical and Instrumentation metering projects along with Electrical, Control & Instrumentation upgrades, Local gas treatment controller replacement and chromatograph upgrades. However as stated these projects were all captured under the Transmission allowances.

A major part of the work programme for RIIO-GD1 has been the delivery of the Offtake USM Meter Upgrade programme, which were all named projects as part of the GD1 submission. This has involved the completion of four-meter upgrades in Scotland and five in Southern at a cost of between £1.5m and £1.9m each giving a total cost of approximately £13.6m. Some have been completed with others currently at the design and installation stage and expected to be completed before the end of GD1.

The total delivery performance for all E&I projects / workstreams was for the following assets:

- Electrical, Instrumentation and Control systems upgrades
- Telemetry upgrade programme
- Gas Quality upgrade/compliance programme (Gas Chromatographs and Gas Trackers)
- Local Gas Treatment upgrades (LGT Controllers)
- Ultra-Sonic Meter upgrades (USM)

Table 2: GD-1 Workload for SGN E&I

Offtake Activity	Scotland	Allowance (£m)	South	Allowance (£m)
Replace telemetry outstations	7	£0.29	10	£0.41
Replace instrumentation, electrical and control systems	5	£1.16	3	£1.04
Orifice plate replacement	4	£6.29	5	£7.39
Gas chromatographs	7	£1.99	8	£1.99
PRS Activity	**Scotland**		**South**	
Replace telemetry outstations	4	£0.20	20	£0.86
Replace instrumentation, electrical and control systems	3	£1.64	15	£5.39

3.6 GD1 lessons learnt

As part of the ongoing Asset Upgrade strategy for GD1, Network E&I's role was to ensure that the Electrical & Instrumentation and Control systems along with other associated assets are operated, maintained and replaced to ensure a safe and reliable network.

During this process, our E&I Asset Engineers and Support Engineers engaged with our Major Construction colleagues to produce specific scope of works, project resourcing/delivery plans and mutually agree the most cost effective and efficient delivery plan.

This level of planning and integration between the Asset Management and Major Construction teams allowed greater planning & co-ordination across project teams and helped develop a smooth stream of work. However, this took a while to get into place and the first couple of years of GD1 were primarily focussed on planning rather than delivery.

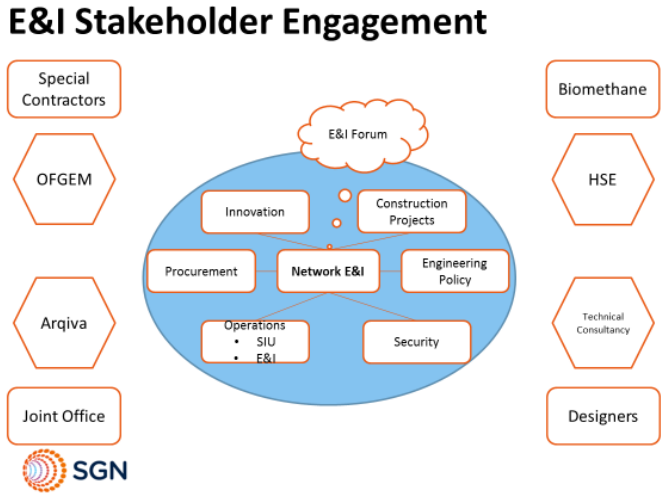
The nature of E&I within the gas industry is unique in many areas and therefore can be difficult to appoint suppliers, designers and contractors who can meet the required level of competency or specialised equipment. At the start of GD1, this resource pool was very restricted, but due to the volume of work over the period, more resources/companies have become available.

Additionally, during GD1, the impact of biomethane being introduced into the network was not fully understood and hence resulted in process inefficiencies.

Therefore, following on from the work undertaken in GD1, the following lessons have been incorporated in how we will deliver our programme during GD2, for example,

- streamline and improve procurement processes in advance of GD2,
- improve design processes & delivery timescales, look at more model designs in preparation for GD2,
- we have improved our methodology for scoping and costing projects due to volume of work in GD1,
- improved biomethane processes, now business as usual,
- wider engineering resource pool, for designers, installers, suppliers etc, more competition, better prices,
- programme working groups to be set up to ensure robust plans are in place to deliver our GD2 plan.

By learning the lesson from GD1, we will be much better prepared for the start of GD2 and ensure our programmes are delivered more efficiently and cost effectively, providing better value for the consumer.



4 Stakeholder insight

Decisions on whether to replace or maintain E&I assets in GD2 will depend on a number of factors. The potential impact of new technology, policy decisions on the future role of the network and in particular the flows and types of gases within the system will have critical bearing on our GD2 investment strategy. We have engaged with customers and stakeholders through our engagement and research programme. The engagement programme and the insights gained are described in more detail in chapter 4 of our business plan and the Enhanced Engagement appendix (022).

Our customers and stakeholders have told us that network safety and reliability is very important to them[3,4]. While customers do not necessarily want less investment in safety and resilience, do not see it as an area of *increasing* focus and expenditure, as they view our performance in GD1 as very good and something we should seek to maintain[5]. We have taken these views into consideration when developing our '4Rs' approach to focus on repair and refurbishment as priority interventions for maintaining network integrity. As indicated above, we have regular meetings with various stakeholder groups which inform and influence how we set our overall objectives, targets and apply our 4Rs strategy.

As detailed below, our E&I activities impact most directly upon two of the three commitments at the heart of our business plan; building a shared future and delivering a safe and efficient service.

4.1 Positive impact

Our customers and stakeholders' value excellent service and initiatives to support customers in vulnerable circumstances. While we are cognisant of our commitment to have a positive impact on society by supporting the communities we serve and providing excellent service, there are no specific insights that have a direct impact on the investment proposition set out in this appendix.

Creating a 'smarter' network

Keeping the gas flowing

Greater application of 'smart' technology across our network will help us to create a low maintenance network that is flexible and fit for the future. Examples include more accurate meters at large 'offtake' sites (which measure gas flows and quality) and remotely operable tools to monitor and control flows of gas through our network of pipes and governors.

This would help:

- Improve our ability for our engineers to identify any potential emerging issues early and respond to changes in gas demand more accurately, making supplies more reliable.
- Improve our environmental performance, as better control over pressures in gas networks will reduce the amount of gas lost through leakage. It would also mean that we'd need to send fewer engineers into the field, so we'll be driving less which would further reduce carbon emissions.

Who pays: Future bill payers

Q. What are your thoughts on this option?

Q. Is there anything else you'd like to see us doing?

4.2 Shared future

Future-proofing of our core assets is critical to ensure a safe and reliable gas distribution network going forward. Our customers and stakeholders have told us that exploring future energy solutions is an area they would like to see prioritised for investment[6,7]. At our Moving Forward Together (MFT) workshops, we have engaged with stakeholders to discuss their views in relation to keeping pace with technological changes and making our network 'smarter'[8,9]. Stakeholders were

[3] Stage 2: Max Diff Prioritisation Phase Report (ref 003,004)

[4] SGN Stakeholder Satisfaction Wave 1 & 3 (ref 071,073)

[5] Stage 1: Explorative Qualitative Workshops and interviews (ref 002)

[6] Stage 1: Explorative Qualitative Workshops and interviews (Exploratory Phase) (ref 002)

[7] Stage 3: Conjoint & WtP Summary report (Valuation Phase) (ref 005)

[8] MFT Workshop March 2018 London & Edinburgh (ref 011,012)

[9] MFT Workshop November 2018 London & Edinburgh (ref 013,014)

generally of the view that it is sensible to be taking steps to keep abreast of technological developments, and that as these technologies advance, the associated costs should come down. It was identified by stakeholders that as the energy system evolves in an effort to decarbonise, the application of smart technology will become increasingly important. A key recommendation that arose from our Sustainability round-table events, held with expert stakeholders in the field of sustainability, was that we should invest in our network to accommodate more low carbon gas.

We worked with stakeholders at MFT workshops to design a set of criteria that could be applied when making investment decisions. Stakeholders viewed future-proofing the network and ensuring flexibility as the second and third most important criteria in Scotland and London respectively, and was seen as one of the least important factors by no more than 5% of stakeholders at either of the workshops.

Our willingness-to-pay research asked to value improvements including designing our network to transport greater amount of 'green' low carbon gas, and we also asked our customers their views in our business plan acceptability testing workshops. Our customer research has shown that investment in future lower carbon energy initiatives attracted the highest willingness to pay values[7]. Customers were given an opportunity at our business plan acceptability testing workshops to indicate their support for building a smarter, more dynamic network that uses more technology to be more responsive to local needs. Future bill payers and hard to reach customers in particular were in favour of this idea[10]. In our quantitative acceptability testing customers were asked a question in relation to the additional element of encouraging more low carbon 'green gas' into the network. This additional element of our plan attracted fairly high total levels of acceptability from both customers in Scotland and southern, at 77% in southern and 81% in Scotland. Domestic customers in Scotland gave this element the highest acceptability (81%), Scotland SME business customers gave this the lowest acceptability (78%)[11].

Taking this feedback into consideration, factors around technological developments and cost reductions are vitally important to E&I as we have the ability, knowledge and expertise to ensure these are incorporated within everything we do. An example of this within our business plan is our metering uncertainty programme which will allow us to gather more useful smart data, improve line-pack for our biomethane producers, reduce maintenance frequencies, work more efficiently by reducing travel, reducing costs and providing more accurate billing information to shippers and customers.

We have also taken on board the feedback from our Customer Engagement Group who have highlighted that more should be done to drive towards whole energy systems. To this end, we are working closely with our Innovation & Energy Systems colleagues to make sure E&I systems are at the forefront of this new emerging energy distribution network. We also held specialist panels and workshops with informed stakeholders to engage on our role in supporting a future decarbonised energy system, which are described in more detail in the Energy Futures appendices (006,007).

During the Oban project to deliver Opening Up the Gas Network, we have been closely involved with the gas quality monitoring systems and worked closely with the HSE to ensure that the SIU exemption was implemented, managed and maintained. The widening of the Wobbe Index range is being used to deliver change across the UK gas distribution system and has wider implications for the UK gas industry in general.

4.3 Safety & efficiency

The customer and stakeholder priorities of acting safely, keeping the gas flowing and keeping costs down are core to guiding the decisions that we are making within our E&I investment proposals for GD2. The E&I programmes of works have been packaged together to allow for volume material price reductions, more cost-efficient project management fees and amalgamated programme design costs. By replacing the E&I

[10] SGN Business Plan Acceptability Testing Phase 1 (ref 078)

11 Business Plan Acceptability Testing Phase 2 (Ref 079)

systems and components identified, it will ensure continued safe, reliable and efficient operation of our key strategic offtake and PRS sites which are monitored and controlled by our assets. Our engagement programme has revealed that customers and stakeholders see these priorities being of paramount importance. to all stakeholders, and in particular vulnerable customers and large gas users.

E&I is a specialist area, and as such, not an area where we have received high-volumes of stakeholder input. However, the specialist stakeholders we have heard from are critical and important in shaping how we deliver our core objectives. Some examples of the specialist stakeholder feedback we've received, and how this has influenced our investment plans include the following:

- During GD-1 a report was submitted by the Health & Safety Laboratories which highlighted that some of our Electrical equipment could not be safely electrically isolated, contained asbestos material and some of our electrical isolation procedures could be improved. As a result, our procedures were improved, and the ageing equipment was included within our GD2 E&I upgrade programmes. Additionally, meetings with the HSE highlight concerns over ageing equipment (CM/4), compliance with cyber security standards and SIU exemption criteria.
- OFGEM have appointed SGS as the official Gas Examiner. We liaise with the gas examiner to ensure our metering and Calorific Value measuring equipment is fit for purpose and meets the requirements of Gas Calculation of Energy Regulations. These decisions have influenced our metering uncertainty programme.
- OFGEM recently approved a new instrument which is termed the Calorific Determining Device (CVDD). These have reduced installation costs and are cheaper to purchase. We have therefore taken this into consideration during our costings for GD2.
- Our annual review programme with Biomethane Delivery Facticity Operators has influenced our metering uncertainty programme and our innovation process by implementing remote pressure control systems which will monitor the outlet pressure of the biomethane network facility.

5 RIIO-GD2 cross sector issue

Commercial Confidentiality

5.1 Decarbonisation & whole system

A large component of E&I expenditure is targeted at improving the data of how our network is performing and increasing the functionality with which we can respond to that data. This is an important enabler to decarbonising the gas network in a safe and reliable manner.

As a part of our E&I programme we have considered the introduction of hydrogen into the gas network. As it is, the decarbonisation pathway remains unclear, as such we have provided an indicative cost that is subject to requirements determined through several feasibility studies which are ongoing. A fuller understanding of the hydrogen network and deployment strategy is necessary to fully cost an engineering solution which is appropriate to the gas network requirements.

The E&I GD2 investment plan is based on maintaining a safe & reliable network, should gas demand fall based on decarbonisation or reduced demands, this investment will still be required as long as gas is required to flow through our pipeline systems. To maintain a safe and reliable network, we will need to monitor gas flows, pressures, temperatures and add suitable levels of stench to ensure gas leaks are detected.

5.2 Innovation

To maximise the utilisation of green gas entering our existing Network Entry Points which are connected to the gas network, the Network E&I team are working in conjunction with colleagues from Strategy, Environment, Innovation & Future of Energy Systems. A synopsis of the E&I involvement is outlined below. Further detailed information and roll out plans are covered within their respective GD2 submission plans.

Biomethane - Maximising and utilisation of green gas at existing entry points

Commercial Confidentiality

In the Southern network, we are working with our customers and suppliers to trial an existing project titled Utonomy. Our Innovation project team are trialling the new system using a remote (screw driver) set point control system which works in conjunction with the local distribution network governors. This would prioritise the injected flow rate from the biomethane entry points to be optimised by line packing our network with biomethane green gas. By working closely with our suppliers, this initiative will be implemented into future designs for biomethane entry facilities. Full implementation of this innovation will also reduce ongoing opex costs by removing the twice-yearly requirement for field-based staff to visit district governors, manually reducing site pressures.

Additionally, we are actively working with our existing Delivery Facility Operators (DFO) who request an increase to the volume of green gas entering the network. Currently we have a number of sites connected and flowing into the network. Many of these customers have already increased their network capacity, with several DFOs requesting further capacity studies. The Biomethane team work closely with Network Planning, Network Strategy, E&I and operational colleagues provide technical solutions to ensure the increased flows are accommodated, greening the gas in our network even further.

Biomethane - propane injection reduction systems

As the UK looks to tackle carbon emissions, we have a number of biomethane injection plants which connect into local distribution zones (LDZ), providing a source of renewable green gas. This plays a major role in the UK's journey towards decarbonisation, and in doing so achieving the government's 2050 carbon reduction target.

A current issue seen with gas entry points is the levels of propane being injected along with the biogas to help increase the energy value of the gas to meet the requirements of the current regulations. Injecting propane is costly to the biomethane producer and reduces the volume of green gas entering our network, impacting our ambitions to lower the carbon content of the gas network. The entry points that currently inject biomethane add propane to increase the energy value of the gas to meet current LDZ Flow Weighted Average Calorific Value (FWACV).

Renewables

This initiative concentrates on the use of renewable energy sources on our operational gas sites. The use of renewables mainly wind energy has been used on our operational gas sites previously. However, this has been used when alternative sources of energy are not available, for example used as a source of power on those sites where a connection to the local electrical distribution connection has not been available.

With the recent advancements in renewable technology which is more efficient at harvesting wind/solar power for storing energy, utilising improvements in battery technology on our sites, will enable energy to be stored for longer, effectively managing the peaks and troughs of this renewable energy which, would have previously been deemed operationally unviable.

USM meter calibration frequencies

For the past few years, SGN have been installing ultrasonic metering systems which have capability for undertaking remote diagnostics. This initiative will explore the possibility of using this diagnostic information to determine not only how the systems are operating, but what other advantages can be achieved by analysing the

data provided. This may allow us to extend current metering maintenance frequencies. Also, within this initiative is the current eight yearly calibration check for these meters which involves removing the meters from the gas line. It is anticipated that this frequency could also be extended.

Wireless technology

As part of innovation funding, we undertook site trials for the utilisation of wireless technology on our operational gas sites. The intent on the project was to analyse the costs savings associated with a reduction in the use of multi-core cables, cable ducting and associated civil costs. Two sites were trialled, and the findings will be used going forward into GD2. On any new large-scale E&I project, wireless technology will be utilised where the cost saving can be justified. It is expected to see the increased use of this new innovative technology.

5.3 Asset resilience (Cyber)

It should be highlighted that as part of our strategy to upgrade our Remote Telemetry Units (RTU's), the international standard IEC 62433 for cyber security and HSE Guidance note (HSE/OG/86) for Cyber Security on Industrial Automation & Control systems will be incorporated into new designs. The IEC 62443 guidelines stipulate the necessary measures to be implemented into designs to achieve specified safety levels for cyber security.

Although overall cyber resilience is not a part of the Network E&I budget submission, these costs have been inserted into table 2, as these are classified as E&I and to demonstrate that Network E&I will be assisting with the delivery of these projects.

The cost of cyber security resilience within the existing Industrial & Automation Control system portfolio on our operational sites has been identified within the IT and Cyber Resilience appendix [011]. The figures below are representative of the E&I requirements. In addition to the costs in **Tables 3** and **4**, there is an associated cost of £350k for project implementation. These costs are illustrative and must not be counted as an addition to the IT and Cyber Resilience Appendix [011].

Table 3: Scotland

Offtakes					
Work Category	**Sub Category**	**Workload numbers**	**Named Project**	**Output**	**Proposed spend**
Commercial Confidentiality					

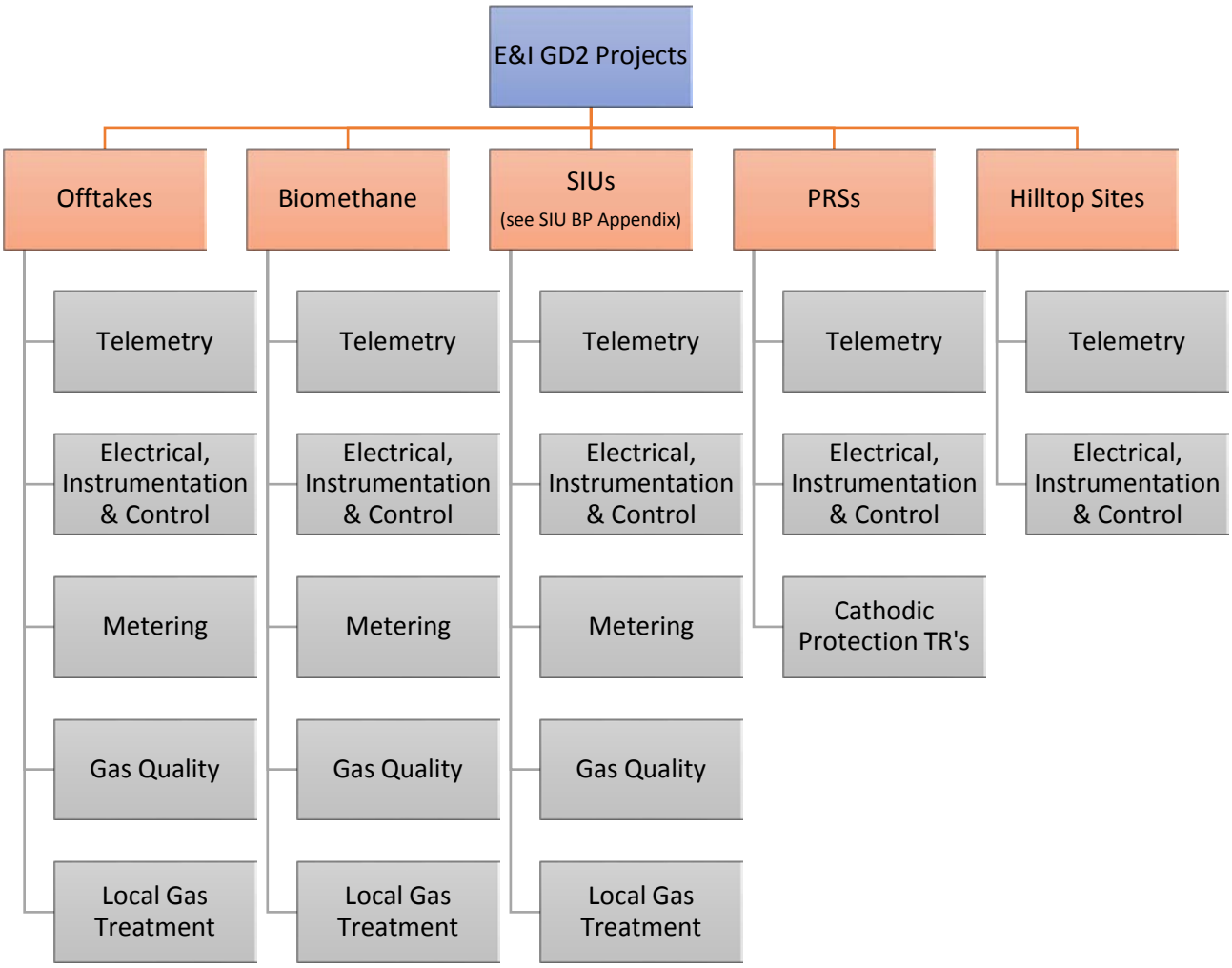
Other					
Work Category	**Sub Category**	**Workload numbers**	**Named Project**	**Output**	**Proposed spend**
Commercial Confidentiality					

Table 4: Southern

Offtakes					
Work Category	**Sub Category**	**Workload numbers**	**Named Project**	**Output**	**Proposed spend**
Commercial Confidentiality					

Other					
Work Category	**Sub Category**	**Workload numbers**	**Named Project**	**Output**	**Proposed spend**
Commercial Confidentiality					

6 GD2 activity breakdown



Based on our 4R strategy as outlined in the section 1 overview, the forecast programme of work for RIIO-GD2 can be divided into twelve work programmes.

Ulysses Telemetry Replacement. Telemetry provides the capability from a distance to monitor only or monitor and control features of operational gas sites. We use telemetry to monitor site status of filters, inlet and outlet pressure, inlet and outlet flows, pre-heating status, reliefs, slam shut systems, valve position adjustments and to facilitate site control such as set point control to direct valve control and vice versa. Telemetry also provides intruder detection alarms. The Ulysses telemetry system which we use is now within the end of life region of the product lifecycle. Spares are not available to purchase, and repairing these units comes with no assurance they could be repaired. To ensure communication and data reliability, we will replace Ulysses telemetry systems with a range of devices which can deliver reliable communication between the site outstation and our gas control centre at Horley. New telemetry units/systems will be cyber security compliant to international standard IEC 62433 which is applicable to Industrial & Automation control systems and will be ready for Industrial Internet of Things (IIoT) & “Industry 4” implementation. The work programme for this includes all our operational gas sites which currently run on Ulysses telemetry at both offtakes and Pressure Reduction Stations (PRSs), 81 sites in Scotland and 84 sites in Southern. (SGN E&I-001Tele-EJP Dec19)

PRS UHF radio replacement. This project is integrated with the Ulysses Replacement Programme, as the radio is integral to the communication link with the Gas Control Centre (GCC). We currently have 188 UHF MDS radio

transceivers installed on our operational sites to provide data transfer between our sites' remote terminal unit and our Scada system within GCC, via our hilltop sites. This was installed circa 1999 at the same time as the Ulysses telemetry system and has been associated with an increasing number of failures with limited availability of spares. This is to be replaced with an MDS NR-104L radio that works in conjunction with new hilltop radios to provide a radio based, wide area network. We are planning a full replacement of 188 obsolete units, 73 in Scotland and 115 in Southern.

Hilltop Upgrade Programme. This project is also integrated with the Ulysses Replacement Programme, as hilltops are integral to the communication link between the RTU, UHF Radio and GCC. We currently have 21 hilltop sites which receive and transmit data from out-stations on its local transmission system (LTS) to the GCC. These sites have been used since the 1970s through a series of radio links. Given their remote location, they are dependent on older generator sets that could result in a loss of power. We are planning to invest across 10 sites at a cost of approximately £35k/site to upgrade these obsolete power supplies.

Controller Replacement Programme. The Bristol Babcock 624 type controllers were designed in the 1970s and installed at offtakes now owned by SGN around 1974 with production ceasing in 2012. The 624 controllers provide local control of pressure and/or temperature at major offtakes and PRS's and STRS's. For the pressure-controlled systems they provide essential high- and low-pressure override functions, giving independent limits of control outside the main electronic system of the site. For temperature the 624s control outlet temperature of the water bath heaters. The role of these devices is a key part to maintaining operation of the major offtakes in Southern and Scotland networks. As part of the asset management strategy, we will be replacing a proportion of the asset population with new controllers and hold the old units as spares for the remaining asset population.

Local Gas Treatment (LGT) Refurbishment Programme. We have a duty to ensure that gas transported on behalf of gas shippers via our integrated pipeline network is sufficiently odorised, so gas leaks can be detected and repaired. This is through the operation of our local gas treatment (LGT) plants. Over GD1, pump failures and alarms have been an on-going issue. In addition, verometer faults while not regular have been occurring on a number of sites. Other issues are related to junction boxes, relief vents, I.S barriers and LGT cabinet corrosion have also been identified. We will be aiming to put a refurbishment plan in place during GD2 to extend the lifecycle of the existing asset populations.

Glenmavis High Voltage Rationalisation. Glenmavis was previously a National Grid owned and operated site, with an SGN offtake located within the site compounds. National Grid had a high voltage infrastructure, and they imported and exported electricity to the grid. In 2014, National Grid no longer required the site, and due to continuity of supply, SGN purchased the site. Due to a number of factors including reduction in opex costs, energy efficiency, competency and asset integrity, we now plan on rationalising the high voltage supply at Glenmavis offtake and move to a low voltage power supply.

Non-Telemetered Sites Work Programme. We have identified 14 sites with preheating (without backup power supply) that are not monitored via telemetry. Recent development in safety studies undertaken by SGN via Hazard and Operability study (HAZOP) / Layers of Protection Analysis (LOPA) have highlighted significant risk of gas escape, loss of supply and explosion because of temperature excursion in the gas pipeline. Freezing of the gas pipeline can result in excursion of the pipeline if not addressed. Due to the requirement to maintain gas flows through these sites and at times these being a single feed into a local distribution network, it is essential we ensure continuity of supply. Failure of the gas heating system and the Joules-Thompson effect will lead to potential freezing of the regulator pilots and loss of supply. (SGN E&I-002NonTele-EJP Dec19)

Cathodic Protection Transformer Rectifiers on above 7Bar pipelines. Our proposal is to have a rolling programme to remove and replace our most critical installations and bring them up to current standards, installing them in ground mounted GRP enclosures. The deteriorating condition of concrete T/R housings now also gives cause for concern. (SGN E&I-003CathProt-EJP Dec19)

Gas Chromatograph Replacement Programme. As a gas transporter, SGN is required to determine the quality of gas as energy conveyed to each consumer. The energy is determined as the product of volume, and the Calorific Value (CV). In some cases, the CV is determined specifically for the consumer, or determined for a charging area

that corresponds with our gas transportation boundary. Currently, the only Ofgem approved instruments able to provide the required levels of accuracy of CV measurement are the Gas Chromatographs and Gas PT2s. These instruments are also capable of very accurate and comprehensive analysis of the composition of the constituent gases, and thus include the ability to monitor gases for ensuring compliance with the Gas Safety (Management) Regulations 1996, Schedule 3 requirements. The Daniels 500 model chromatographs will be deemed obsolete and unsupported from 2020 and there has been a significant rise in the number of faults recorded. We are looking to replace them with approved devices such as Emerson's 370XA, Honeywell EnCal 3000 or Orbital Gas PT2.

Inter LDZ Metering Programme. The scope of this project covers the replacement of Ofgem noncompliant gas analysers (now obsolete) across the 4 sites identified. It also covers replacing and/or revamping associated Electrical and Instrumentation (E&I) assets which include flow computers, communication into Supervisory Control and Data Acquisition (SCADA) and High-Pressure Meter Information System (HPMIS), battery systems, power supply units, and GRP kiosk.

Metering Uncertainty Programme. We have carried out an independent metering review using independent metering experts to produce a detailed fiscal metering technical report. The gas flow metering systems on these offtake sites are vitally important for correct Ofgem approved fiscal custody transfer of the gas flow from the National Transmission system operated by National Grid and correctly odorising the gas as part of an integrated Flow Weight Average Calorific Value (FWACV) system into the downstream distribution network. The existing offtake metering systems were not designed to operate with these additional biomethane sources of gas injection to the local downstream network with subsequent very low flow across the offtake metering system. As a consequence, the metering system uncertainty of measurement required by Ofgem cannot always be guaranteed to remain within tolerance at very low flows typically at night in the summer. This also affects the accuracy of odorisation as the stenching system needs to operate on default settings in these low flow conditions where the meter system readings may be infrequent. (SGN E&I-004Meter-EJP Dec19)

Electrical, Instrumentation and Control Upgrade Programme. A number of SGN electrical equipment contains asbestos as this material was used within fused switchgear, fuse boards or behind ceramic fuses. A lot of our older electrical equipment does not allow safe isolations using our approved safe isolation procedure. On our older sites a lot of the equipment was installed pre-ATEX, and as a result we are non-compliant with ATEX/DSEAR and there is significant remediation work to be done. (SGN E&I-005E&IUpgrades-EJP Dec19)

Instrumented Safety System Compliance Programme. In the South-East of our network we currently have nineteen sites with legacy instrumented safety systems. These systems comprise of a sensing pressure switch on the stream outlet manifold to the site. Through a relay, the switch energises a solenoid valve actuating a Kinatrol unit to fire the slam shut. During the GD1 period we have started a programme to replace the sensing pressure switch and actuating solenoid for devices with higher reliability inside standalone cabinets.

Industrial & Commercial Metering Data Loggers. The majority of our current Metretek GSM24 AMR devices were installed 10 years ago, prior to GD1, and have since been discontinued. In order to manage gas consumption across the network, it is essential we replace faulty devices and achieve aggregate targets set by the Central Data Services Provider (CDSP) committee. In 2018, engineers attended to 1738 faults across both Scotland and Southern networks. Around 5% of these faults resulted in full replacement of the hardware on site. This project will find a solution to the obsolete hardware and software allowing for continued data output, while also aiming to reduce the number of faults being attended to through the installation of new and more reliable devices. (SGN E&I-006ICMDatalog-EJP Dec19)

E&I Minor Works Programme. This is a repair programme to ensure replacement/refurbishment of defective components and extending the whole system life-cycle. This is an ongoing requirement to respond to E&I equipment asset integrity issues reported/arising on offtakes and PRS which are out of the scope for opex maintenance budgets. These are limited to smaller projects where on condition replacement of E&I assets are required which cannot be repaired due to poor condition e.g. severe corrosion, kiosk deterioration, equipment failure damage due to lighting strikes etc. (SGN E&I-007MinorW-EJP Dec19)

6.1 Approach to GD2

Our approach to GD2 as outlined in section in 1.1 is to use the 4R strategy to target the oldest and most critical asset groups to ensure our E&I systems remain safe and reliable. The age profile of the E&I systems and equipment varies significantly, and in line with our CM/4 process we undertake a review of these asset groups to understand the impact of failures at component and system level.

6.1(b) Impact of government policy

Within the E&I Business Plan there will be very little impact of government policy. However, cognisance of The Committee on Climate Change and the drive to net zero carbon emissions in the UK will drive our decision-making process on the selection of equipment and how we undertake our work programme. We will ensure all our new equipment is more environmentally friendly by installing low energy equipment and where possible look at alternative forms of energy. The only potentially significant impact for E&I within GD2, will be the replacement of hazardous area equipment should the levels of hydrogen within the gas composition change significantly. For example, the current chromatographs installed at our offtakes are not suitable for higher levels of hydrogen. During GD2 we will ensure any new equipment installed is ready for this change.

6.1(c) Scenarios and sensitivities

Within each investment area, an engineering justification paper and cost benefit analysis has been completed. Within these a preferred investment option has been selected, this is generally the option which gives the most cost effective, safe and reliable option. For this option, we have applied positive and negative sensitivities on variables such as capex and opex expenditure – dependent on the risk categories for each investment. The result of these sensitivities has then been reflected in the engineering justification papers and cost benefit analysis.

As an example, we have calculated a conservative, base cost to carry out a programme of works to replace our existing population of Ulysses Telemetry units. A reduction of 15% on capex has been applied for a low case scenario if we can achieve greater than expected discounts on material purchase and also if greater efficiencies can be achieved in projects delivery that have not already been fed into the base costs – this would improve processes and streamlining working practices to reduce mobilisation time on site. This has been fed onto the engineering justification papers and been compared against the base case and a high case scenario.

6.2 GD2 outputs and Price Control Deliverables

Network E&I have not identified any projects that would invoke this mechanism. However, please note that the investment necessary to move to a 20% hydrogen mix could be included in a future of heat reopener and this will be covered within our Energy Futures appendices (006 & 007).

We do not anticipate any of the investment proposed within this appendix being defined as a price control deliverable or being considered under a use-it or lose-it mechanism.

6.2.1 Southern network deliverables

The items below are the deliverables for Network Electrical and Instrumentation appendix for the Southern network:

Southern							
Activity	Programme of Works / Project	Annual Spend (£m)					Total (£m)
		21/22	22/23	23/24	24/25	25/26	GD2
PRS	Telemetry Upgrade (82 PRS')	0.855	0.795	0.803	0.806	0.888	4.146
	Non-telemetered Pre heating sites (14 sites)	0.318	0.296	0.299	0.300	0.330	1.542
	Cathodic Protection T/R Upgrades (40)	0.138	0.128	0.130	0.130	0.143	0.669
	E&I Upgrade Programme (23 sites)	1.046	0.972	0.982	0.985	1.085	5.069
	E&I Minor Works	0.300	0.279	0.282	0.283	0.311	1.455
	<£0.5m	0.276	0.256	0.259	0.260	0.286	1.337
	Total PRS	2.933	2.726	2.754	2.763	3.044	14.220
Offtakes	Telemetry Upgrades (2 Offtakes)	0.026	0.024	0.024	0.025	0.027	0.126
	Metering Uncertainty Programme (1 site)	0.052	0.048	0.049	0.049	0.054	0.253
	E&I Upgrade Programme (2 sites)	0.149	0.138	0.140	0.140	0.154	0.721
	ICMDL	1.221	0.786	0.794	0.796	0.877	4.474
	<£0.5m	0.233	0.217	0.219	0.220	0.242	1.130
	Total Offtakes	1.681	1.213	1.226	1.230	1.355	6.704

6.2.2 Scotland network deliverables

The items below are the deliverables for the Network Electrical and Instrumentation appendix for the Scotland network:

Scotland							
Activity	Programme of Works / Project	Annual Spend (£m)					Total (£m)
		21/22	22/23	23/24	24/25	25/26	GD2
PRS	Telemetry Upgrade (73 PRS')	0.732	0.694	0.683	0.747	0.797	3.654
	E&I Upgrade Programme (4 sites)	0.163	0.155	0.152	0.166	0.177	0.813
	E&I Minor Works (~15 sites)	0.100	0.095	0.094	0.102	0.109	0.501
	Cathodic Protection T/R Upgrades (15)	0.050	0.047	0.046	0.051	0.054	0.248
	<£0.5m	0.118	0.112	0.110	0.120	0.129	0.589
	Total PRS	1.164	1.103	1.085	1.187	1.267	5.805
Offtakes	Telemetry Upgrades (8 Offtakes)	0.100	0.095	0.094	0.102	0.109	0.501
	Metering Uncertainty Programme (6 sites)	0.833	0.789	0.776	0.849	0.907	4.154
	E&I Upgrade Programme (5 sites)	0.314	0.297	0.292	0.320	0.341	1.564
	ICMDL	0.905	0.516	0.507	0.555	0.592	3.074
	<£0.5m	0.234	0.222	0.218	0.239	0.255	1.168
	Total Offtakes	2.386	1.919	1.887	2.065	2.204	10.462

6.3 Bespoke outputs

There are no proposed bespoke outputs for the E&I delivery programme as they have no direct impact on consumer value.

6.4 Investment in existing assets

There are no Network Asset Risk Measures (NARMS) associated with E&I asset groups. Therefore, a detailed CBA has been completed for each E&I work programme above £0.5m. Various options were explored from, do nothing, repair, or replace. The most cost effective and efficient way has been used to maximise benefit for our customers, best cost alternative and efficient method.

For the I,C & Metering Datalogger Replacement programme, several options were considered, these being:

- Full programme of works – this being replacement of all units currently in the field
- A staged replacement i.e. 50% in this price control
- A reactive approach to replacement – this being replacement on failure.

As part of this CBA, the option which represented the best value to the customer while maintaining a safe and reliable network, was a 50% replacement in the GD2 price control period as it allowed for greater material discounts and other cost savings such as a significant reduction in design, installation and project management costs.
The staged approach and reactive approach both included higher capex costs but also incurred a significant increase in opex.

Each workstream has undergone the same process as this, and the option with the largest Net Present Value (NPV) was generally the preferred option. An example of this being that Network E&I proposed the full replacement of pneumatic controllers, but the CBA dictated a 50% replacement programme was a more cost-effective solution whilst still providing an acceptable engineering solution, therefore Network E&I adjusted their budget request to reflect this.

6.5 Engineering Justification Papers

Each Engineering Justification Paper (EJP) produced by Network E&I strictly seeks to answer the Appendix B Framework set by Ofgem. Network E&I have not deviated from the structure. All our workstreams are Appendix B compliant, and no Appendix A projects have been identified.

Each EJP has undergone a validation and verification process with an external independent person and allows SGN to ensure there is a high level of confidence in the assurance process for these EJP's.

For each work programme an EJP has been completed which defines the problem and consequences of failure, then analyses the engineering options and provides technical solutions to the rationale behind the justification.

Table 5: Workstream Engineering Justification Paper references - Scotland

Project/Workstream	No.	Value £m	NPV (£m)	Payback (years)	Engineering Justification Paper - Reference
Telemetry	81	£4.2	5.9	0	SGN E&I – 001 Tele – EJP Dec19
UHF Radio Replacement	73	£0.3			SGN E&I – 001 Tele – EJP Dec19
Hilltop Upgrade	1	£0.1			SGN E&I – 001 Tele – EJP Dec19
Pneumatic Controllers	26	£0.3			<0.5m
LGT Refurbishments	36	£0.4			<0.5m
Glenmavis HV Rationalisation	1	£0.3			<0.5m
CPTR	15	£0.3	0.8	0	SGN E&I – 003CathProt – EJP Dec19
Gas Chromatograph Upgrades	2	£0.3			<0.5m
Inter LDZ Metering	1	£0.1			<0.5m
Metering Uncertainty	6	£4.2	0.2	26	SGN E&I – 004Meter – EJP Dec19
EC&I Upgrades	9	£2.4	2.4	0	SGN E&I – 005E&IUpgrades – EJP Dec19
I&C Metering Dataloggers	596	£3.1	2.9	0	SGN E&I – 006ICMDatalog – EJP Dec19
E&I Minor Works Programme	15	£0.5	2.5	0	SGN E&I – 007MinorW – EJP Dec19
Total		**£16.5**	**£14.7**		

Table 6: Workstream Engineering Justification Paper references – South of England

Project/Workstream	No.	Value £m	NPV (£m)	Payback (years)	Engineering Justification Paper - Reference
Telemetry	84	£4.3	6.1	1	SGN E&I – 001 Tele – EJP Dec19
UHF Radio Replacement	115	£0.4			SGN E&I – 001 Tele – EJP Dec19
Hilltop Upgrade	1	£0.04			SGN E&I – 001 Tele – EJP Dec19
Hilltop Battery Replacement	8	£0.2			SGN E&I – 001 Tele – EJP Dec19
Pneumatic Controllers	41	£0.4			<0.5m
LGT Refurbishments	30	£0.4			<0.5m
Non-Telemetered sites	14	£1.5	0.8	15	SGN E&I- 002NonTele – EJP Dec19
CPTR	40	£0.7	2.1	0	SGN E&I – 003CathProt – EJP Dec19
Gas Chromatograph Upgrades	2	£0.4			<0.5m
Inter LDZ Metering	3	£0.4			<0.5m
Metering Uncertainty	1	£0.3	5.6	0	SGN E&I – 004Meter – EJP Dec19
EC&I Upgrades	45	£5.8	5.3	9	SGN E&I – 005E&IUpgrades – EJP Dec19
Functional Safety	19	£0.2			SGN E&I – 005E&IUpgrades – EJP Dec19
I&C Metering Dataloggers	1092	£4.5	5.5	0	SGN E&I – 006ICMDatalog – EJP Dec19
E&I Minor Works Programme	21	£1.5	2.2	9	SGN E&I – 007MinorW – EJP Dec19
Total		**£21.0**	**£27.6**		

6.6 Investment in new assets

Within the GD2 E&I business plan there are no proposals to invest in new asset groups. However, it should be noted that within section 6.8, Managing uncertainty, there are some estimated costs for Hydrogen in the Gas Network**,** but further detail will be provided within the business plan associated with Energy Futures appendices (006 & 007).

6.7 Cost Efficiency

For the purposes of the business plan submission in December 2019, we have made our current forecast on the following basis:

- that cost pressures between 17/18 and the start of the price control 21/22 will be equal to CPI,
- during August 2019, to demonstrate cost-based assurance for the E&I submission, four of the larger programmes of work were sent out to the market with high level scopes for competitive budget quotations,
- thus, obtaining an evidence base which is built on current market conditions as opposed to historical, benchmarked data,
- for the four workstreams, we requested contractors to logically break down quotations thus presenting granular elements, so we could modularly build project forecasts from a real monetary evidence base,
- that the figures presented above, and the workloads forecasts have a high level of confidence. While we will continue to build the evidence base and challenge our assumptions, we do not anticipate significant variations,
- network E&I have amended their budget to reflect the current market value based on the tenders. This was an example of Network E&I establishing a higher confidence cost base for the monies requested to date. Further information can be obtained from the Procurement & Native Competition appendix (010).

6.8 Managing uncertainty

We do not anticipate any of the investment proposed within this appendix being defined as a price control deliverable or being considered under a use-it-or-lose-it mechanism.

Network E&I have not identified any projects that would invoke this mechanism. However, please note that the investment necessary to move to a 20% hydrogen mix could be included in a future of heat reopener.

Option - 20% hydrogen preparedness

We are currently exploring the option of further investment in the E&I systems necessary to move towards a 20% hydrogen network. The costs set out below are current estimates for the systems necessary to allow for the analysis of gas quality, metering and odorisation of the gas in the network at national Offtake sites. These options will be captured under the Business Plan appendix on Energy Futures appendices (006 & 007) and are mentioned in this section to demonstrate the impact on E&I.

Table 7: Strategic Option: 20% hydrogen mix – Gas processed at national offtake site

Scotland	Description	OFGEM Output	Workload Numbers	Unit Costs £k	Total Costs £m
Offtakes	LGT Upgrade	LGT Systems	18	£130	£2.34
	Full GC System Upgrade	Gas Quality	9	£200	£1.80
	Full PT Upgrade	Gas Quality	9	£55	£0.49
	Total				**£4.63**

Southern	Description	OFGEM Output	Workload Numbers	Unit Costs £k	Total Costs £m
Offtakes	LGT Upgrade	LGT Systems	12	£130	£1.56
	Full GC System Upgrade	Gas Quality	12	£200	£2.4
	Total				**£3.96**

6.9 Competition

As with all our major construction projects, we will competitively tender all works to ensure the best possible price for our customers and shareholders. All tender events will be executed by our Procurement department assisted with the relevant technical experts, where both parties will evaluate the bids, ensuring best technical solution to meet the most competitively based price. For further detail please refer to Procurement & Native Competition appendix (010).

6.10 Real Price Effects

The costs in this paper have been calculated using previous project costs for similar type projects. The previous projects have been through a tender evaluation process, and the prices are accurate as of the 2018/2019 financial year. A recent example of this was the Gas Offtake Fiscal Metering Skid Units and Control Systems Tender which was conducted under SGN and UK procurement laws (Tender Reference Number 2301(2344). Further details can be provided by Procurement on request.

In line with company procedures, all the proposed E&I programmes of work will be tendered, and the contract awarded based on technical compliance and cost. For further detail on contract strategy, further information can be found in the GD2 Procurement & Native Competition appendix (010) of the Business Plan.

At the start of GD1 due to specialist nature of the E&I equipment involved, it was difficult to formally tender some of the more specialised upgrade works, and a few single source awards were required. However, this has now

changed due to the procurement strategy in GD1 and involvement with major construction projects. During GD2 we are now assured that formal competitive tendering will be available across all our work programmes.

6.11 Financial summary

As E&I was not a separate deliverable within the GD1 business plan, there are no separated costs associated with this programme of work to compare GD1 to GD2. During GD1 these costs were accounted for within the Transmission budget.

The table below demonstrates the investment proposal for Electrical and Instrumentation works throughout GD2. These costs do not include any investment on mechanical transmission assets. Details of mechanical transmission investment can be found in the Transmission Integrity appendix (021).

The investment proposals below are contained within the LTS, Storage and Entry tab, 3.01 of the BPDT.

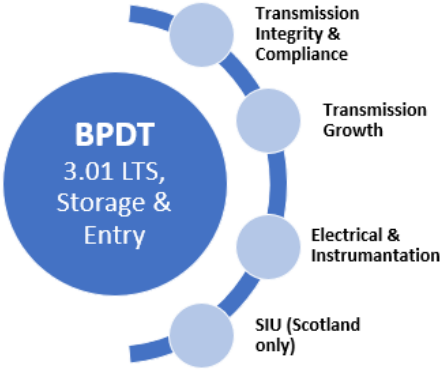


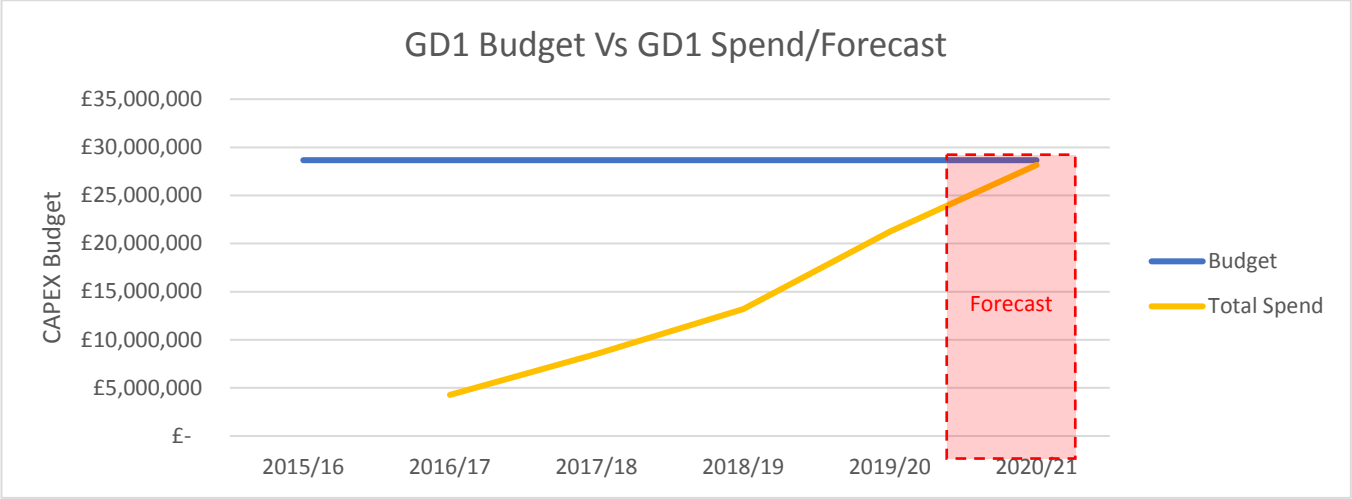
Table 8: RIIO-GD2 Electrical and Instrumentation investment proposal.[12]

SGN (£m)	13/14	14/15	15/16	16/17	17/18	18/19	19/20	20/21	21/22	22/23	23/24	24/25	25/26
Offtakes	1.4	0.3	0.8	1.2	2.2	5.8	13.9	10.9	4.1	3.1	3.1	3.3	3.6
PRSs	3.9	13.6	23.9	36.6	27.4	29.9	18.7	11.3	4.1	3.8	3.8	4.0	4.3
Total[13]	5.3	13.9	24.7	37.8	29.6	35.7	32.6	22.2	8.2	7.0	7.0	7.2	7.9
Scotland (£m)	**13/14**	**14/15**	**15/16**	**16/17**	**17/18**	**18/19**	**19/20**	**20/21**	**21/22**	**22/23**	**23/24**	**24/25**	**25/26**
Offtakes	1.4	0.2	0.7	1.1	1.2	3.7	6.2	1.1	2.4	1.9	1.9	2.1	2.2
PRSs	1.2	6.9	12.8	14.1	9.0	11.4	5.4	5.8	1.2	1.1	1.1	1.2	1.3
Total[13]	2.6	7.1	13.5	15.2	10.2	15.1	11.6	6.9	3.6	3.0	3.0	3.3	3.5
Southern (£m)	**13/14**	**14/15**	**15/16**	**16/17**	**17/18**	**18/19**	**19/20**	**20/21**	**21/22**	**22/23**	**23/24**	**24/25**	**25/26**
Offtakes	0.0	0.1	0.1	0.1	0.9	2.1	7.6	9.7	1.7	1.2	1.2	1.2	1.4
PRSs	2.6	6.7	11.1	22.5	18.4	18.5	13.2	5.5	2.9	2.7	2.8	2.8	3.0
Total[13]	2.6	6.8	11.2	22.6	19.3	20.6	20.8	15.2	4.6	3.9	4.0	4.0	4.4

The graph below shows the annual spend against the set budget for E&I activities shown in Table 2.

[12] All costs shown are in 2018/2019 prices

[13] Pre-GD2 totals have been taken from Transmission Integrity Appendix 021, where the total figures are provided, which includes pre-GD2 E&I.



6.12 Assurance

Our Business Plan, including Appendices, has been subject to a rigorous assurance process which is detailed in Chapter 3 of the Plan and the Board Assurance Statement.

Our Network Director was appointed as the Sponsor for the Electrical and Instrumentation (E&I) Appendix and the associated Cost Benefit Analyses (CBAs), Engineering Justification Papers (EJPs) and Business Plan Data Templates (BPDTs); which have been through the following levels of review and assurance:

First Line

This was undertaken at project level by the team producing the document, as a regular self-check or peer review.

Second Line

This was undertaken independently within the organisation to review and feedback on product development, including GD2 workshops on Capital Expenditure (CAPEX), CBAs and EJPs and a high-level cost benchmarking exercise conducted by Procurement. Internal Audit reviewed the third line assurance work conducted by Ove Arup and Partners against scope.

Both Senior Manager and Director sign-off was obtained and our RIIO-GD2 Executive Committee: (1) considered the appropriateness of assurance activity for the Appendix and (2) provided assurance to SGN's Board that the Business Plan meets Ofgem's assurance requirements.

Third Line

This was undertaken by external advisors and groups providing critical challenge during the development of products within the Business Plan. In addition to the feedback and challenge provided by the Customer Engagement Group (CEG) and Customer Challenge Group (CCG) this Appendix was developed after consultation with and advice from:

Advisor / Group	Contribution
Ove Arup and Partners	Consultancy support to enable development of an evidence based high quality business plan draft by acting as an expert challenge group through independent peer reviews against Ofgem Business Plan Guidance.
Kelton's	Consultancy Support on summer meters

Fourth Line

This was undertaken by independent and impartial external providers, who provided a detailed and comprehensive report to both the Executive Committee and Board of Directors:

Advisor / Group	Contribution
Ove Arup and Partners ('Clean' Team)	Review of Appendix against Ofgem's assurance requirements.
PwC	Business Plan Data Template review: LTS, Storage & Entry and Other Capex

7 Glossary

All acronyms and associated descriptions can be found within the Glossary appendix.

8 Project summary

This section gives a high-level overview of each workstream proposal. An Engineering Justification Paper has been produced for each workstream proposal and includes greater detail for justifications, data and costing information. The below table shows the references to the corresponding Engineering Justification Paper.

Table 9: Workstream Engineering Justification Paper References

Project/Workstream	Engineering Justification Paper - Reference
Ulysses Telemetry Replacement Programme	SGN E&I – 001 Tele – EJP Dec19
UHF Radio Replacements	
Hilltops Upgrade Programme	
Hilltop Battery Replacement Programme	
Pneumatic Controller Replacement Programme	N/A
LGT Refurbishment Programme	N/A
Glenmavis HV Rationalisation Project	N/A
Non-Telemetered Sites Work Programme	SGN E&I- 002NonTele – EJP Dec19
Cathodic Protection TR Replacement Programme	SGN E&I – 003CathProt – EJP Dec19
Gas Chromatograph Replacement Programme	N/A
Inter LDZ Metering Replacement Programme	N/A
Metering Uncertainty Programme	SGN E&I – 004Meter – EJP Dec19
Electrical, Instrumentation and Control Replacement Programme	SGN E&I – 005E&IUpgrades – EJP Dec19
Industrial & Commercial Metering Datalogger Replacement	SGN E&I – 006ICMDatalog – EJP Dec19
E&I Minor Repair Works Programme	SGN E&I – 007MinorW – EJP Dec19

Project appendices list

8.1 Ulysses Telemetry Replacement Programme

Ulysses Replacement Programme

Background

Telemetry provides the capability from a distance to monitor only or monitor and control features of operational gas sites. SGN uses telemetry to monitor site status of filters, inlet and outlet pressure, inlet and outlet flows, pre-heating status, reliefs, slam shut systems, valve position adjustments and to facilitate site control such as set point control to direct valve control and vice versa. Telemetry also provides intruder detection alarms.

The Ulysses telemetry system which we use is now within the end of life region of the product lifecycle. Spares are not available to purchase, and repairing these units comes with no assurance they could be repaired. There are four major factors/components that affect the functionality of the Remote Telemetry Unit (RTU).

These are:

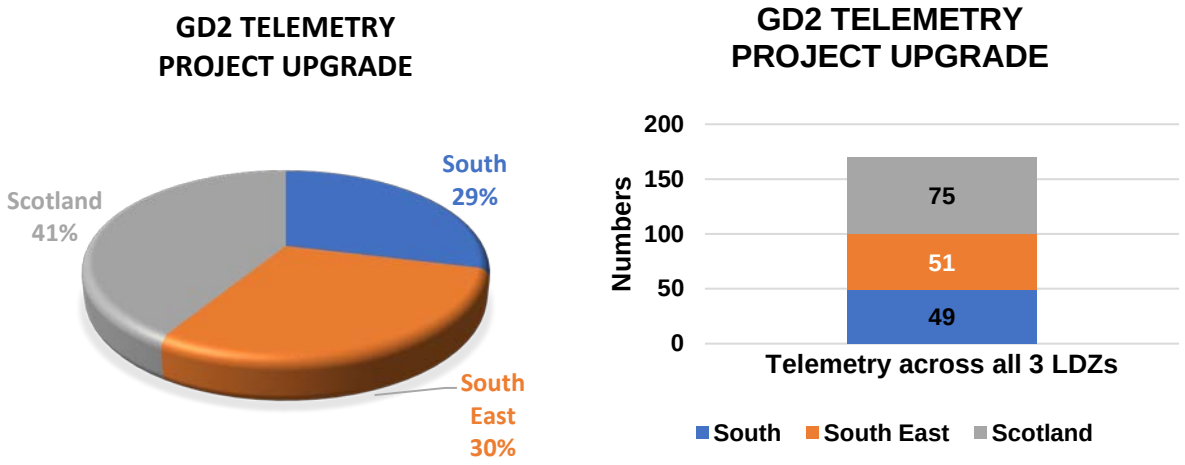
Commercial Confidentiality, Security

- Profibus cards – these are no longer manufactured to suit the RTU footprint.
- 4-serial ports – these are known to have voltage issues.
- Back-up batteries within the RTU – failures of the batteries are common, and they play a vital role within the RTU for remote control operations and due to the age, they are known to not hold their charge.
- The recommended lifetime for electronic products is circa 15 – 20 years, and the RTU has now reached this stage.

Scope of Works:

To ensure communication and data reliability,
SGN will replace Ulysses telemetry systems with a suitable device which can deliver a reliable communication between the site outstation and gas control centre at Horley in GD2. New telemetry units/systems will be cyber security compliant to international standard IEC 62433 which is applicable to Industrial & Automation control systems and will be ready for Industrial Internet of Things (IIoT) & “Industry 4” implementation. The work programme for this includes all SGN operational gas sites which currently run on Ulysses telemetry at both offtakes and Pressure Reduction Stations (PRS’).

Figure 5: Number of RTU upgrades proposed in GD2



Key legislative compliance:

Under 'SGN/PM/INE/2 – Management Procedure for Selection of Telemetry to Operate the SGN Gas Supply System' telemetry is essential to ensure supply demand management, where GCC interprets the data coming from site to determine daily balancing of gas supply and demand.

Also, telemetry allows GCC to have a centralised overview of the prevailing condition of the gas network. Telemetry data is used to validate and improve theoretical network models and to inform investment decisions.

The Uniform Network Code (UNC) comprises a legal and contractual framework to supply and transport gas. It has a common set of rules for all industry players which ensure that competition can be facilitated on level terms. Under the UNC, SGN must provide National Grid Transmission (NTS) with certain real-time data about gas flows and demand within the SGN network.

In addition, the operating systems of the existing Ulysses RTUs are no longer supported, neither is the systems firmware, meaning the system can no longer be updated or be patched to protect against viruses/malware or new cyber-attacks and cannot support up to date anti-virus software.

Upgrading these units, would allow for compliance with IEC 62443 Cyber Security standards which in turn support Network and Information Systems (NIS) Directive compliance.

Impact of losing asset:

Blean PRI had a few faults captured via telemetry on three occasions between 2017 and 2018. Faults on the pre-heating boiler system and generator were sent via alarms to the gas control centre allowing operatives to attend the site on time to remediate the issue in a safe manner.

This site feeds approximately 17,000 houses. Failure to address these issues onsite could have resulted in loss of gas supply.

Tonbridge PRI feeds 8,600 houses and has also experienced faults such as flow indications, filter differential pressure, and pre-heating boiler faults between the periods of 2015 and 2018. These faults were alarmed and sent to the gas control centre via telemetry allowing operatives to attend the site in a timely manner to fix the issues identified onsite.

Without telemetry onsite, SGN operatives would have to rely on local knowledge, and frequent site visits typically once a week during the winter months and then once a month at low demand periods to ensure that gas is safely transported to consumers. This may result in human factor errors and an increase in opex costs and have an increased environmental emission impact due to transportation.

The importance of telemetry onsite cannot be overemphasized as it provides timely intervention to avoid

catastrophic failures, provides detailed real-time information of gas properties, helps to secure sites from intruders, provides information to gas control operatives to forecast gas demands, etc.

Costs:

The costs for an RTU upgrade vary depending on whether it is for an offtake or a PRS. This is due to the difference in telemetry points/signals and complexity of sites. We have used a cost of £50,000 per site for offtakes and £40,000 for PRSs. This is because it is recognised that project management, design costs, materials and installation costs can be reduced by tendering for the work as a whole package.

8.2 PRS UHF Radio Replacement

This project is integrated with the Ulysses Replacement Programme, as the Radio is integral to the communication link between the RTU and GCC (see figure 1).

Background

SGN currently have 188 UHF MDS radio transceivers installed on our operational sites to provide data transfer between our sites remote terminal unit and our Scada system within GCC, via our hilltop sites.

The MDS NR-104L radio is a synthesised unit that provides MPT1411 communications to SGN gas network. It works in conjunction with new hilltop radios to provide a radio based, wide area network.

The radio connects to the RTU via a serial link and is powered from a 12V DC supply. It has 4 LEDs on the front panel to show its operational state. It does not require any regular maintenance.

Figure 6: MDS NR-104L Radio

The MDS NR-104L radio was installed circa 1999 when the Ulysses telemetry system was installed across SGN National Transmission Stations (NTS) and Pressure Reduction Installations (PRIs). These radio systems are no longer supported by the manufacturers and are deemed to be near the end of their working life.

SGN maintenance operatives over the last two years have seen an increased number of failures on MDS radios. The limited spares available to SGN are running out quickly and there is no certainty this will suffice before the end of GD2. Generally during the summer periods, we are seeing an increased effect on our radio systems due to tropospheric interference.

Scope of Works:

Currently SGN are undertaking multiple communication trials including a 4RF trial, using Aprisa 4RF radio transceivers installed on our hilltop and operational trial sites. So far this has proven that the 4RF radios offer significantly improved performance, particularly during tropospheric interference events.

Figure 7: Aprisa 4RF Radio

Full replacement of our 188 obsolete MDS radio transceivers on our operational distribution/transmission sites will form the scope of works for this project.

What is out of scope:

Ancillary equipment installed on site i.e. aerial masts, cabling, routers and switches.

Impact of losing asset:

The UHF radio is an integral part of the SGN Communications network and is integrated with the RTU and the hilltop sites, and thus loss of this asset will result in the same impact as previously mentioned in the Ulysses telemetry replacement section.

Figure 6: Typical Radio Configuration Communicating with Hilltops

Commercial Confidentiality, Security

8.3 Hilltop Upgrade Programme

This project is integrated with the Ulysses Replacement Programme, and UHF Radio replacement programme as the hilltops are integral to the communication link between the RTU, UHF Radio and GCC (see figure 7).

Background:

SGN currently operates 21 hilltop sites which receive and transmit data collected from outstations on its Local Transmission System (LTS) and sends that data to its Gas Control Centre (GCC). 14 of these sites serve the Southern Network and the remaining 7 serve Scotland. These communication systems have been in use since circa 1970s.

UHF signals are sent via a remote radio to another master radio which is installed at the base station. The master radios, and all the remote radios, form a continuous network over which data to and from the telemetry system is transmitted. The radio system also includes a Network Management System, which gives a centralised view of how the radio system is operating and allows its operators to identify whether an individual radio unit is working correctly.

Figure 7: Typical Hilltop Configuration

Security, Commercial Confidentiality

All the hilltop installations pre-date the 1990s with the majority still retaining their original electrical installations and equipment, most of which is no longer supported by the equipment manufacturers.

By their very nature, hilltop installations are normally located at high points, which are not the most easily accessible, particularly during severe weather conditions. Equipment reliability is a primary operational requirement when considering extreme gas demands on the system.

Scope of works:

24v battery charger systems and backup electrical generators require replacement. This will include the installation of generators on sites that are not already supported and the replacement of generators that have reached end of life.

Figure 8: Typical example of obsolete diesel generator at hilltop site

What is out of scope:

Communication equipment has not been included within this proposal. This will be addressed by our IT department who are responsible for this asset.

Key legislative compliance:

SGN must comply with the Electricity at Work Regulations 1989 to ensure safe systems of works are being implemented and electrical systems and equipment are adequately designed to ensure safe operation and maintenance.

The redundancy and criticality of our hilltop sites must consider the requirements of SGN/PM/INE/2 to ensure our telemetry network continued operation.

Impact of losing asset:

The power supply systems across the hilltop base stations are showing signs of deterioration. Loss of power to a hilltop will affect all the communication links common to that hilltop and SGN gas control centre. The effect of having communications failures will be catastrophic because this becomes a common mode failure source.

SGN sites may be susceptible to security breach or loss of gas supply to consumers without the knowledge of SGN GCC operatives, should a communications failure between GCC and the hilltops occur.

8.4 Pneumatic Controller Replacement Programme

Background:

The Bristol Babcock 624 type controllers were designed in the 1970's and installed at offtakes now owned by SGN around 1974 with production ceasing in 2012.

The 624 controllers provide local control of pressure and/or temperature at major offtakes and PRSs and STRSs. For the pressure-controlled gas site systems they provide essential high- and low-pressure override functions, giving independent limits of control outside the main electronic system of the site. For temperature the 624s control outlet temperature of the water bath heaters. These devices play a key role to maintaining operation of the major offtakes in the Southern and Scotland networks.

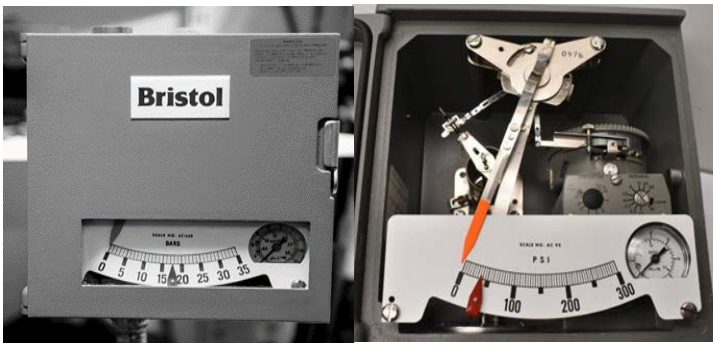
With the buyout of Bristol Babcock by Emerson in 2012, they confirmed that production of the 624 controllers would cease. To ensure spares within SGN, a survey was undertaken on the number of controllers in use in the Scotland and Southern networks, which resulted in around 28 controllers and various overhaul kits being purchased (£128,000) in late 2012.

Scope of works:

This programme of works proposes the replacement of Bristol Babcock 624 pneumatic controllers for the OMC Series 350 PID controller or similar.

This work stream will concentrate on replacing the existing controllers with the OMC Series 350 PID controller which provides the same functionality. The footprint for the proposed alternative devices is different from that of the 624 controllers and would require new piping arrangements for installation into the existing override cabinets where possible. This additional piping work has been allowed for in the costs submitted as part of this business plan.

Figure 9: Bristol Babcock 642 Controller



The numbers of controllers currently installed at the major offtakes and PRSs derived from survey lists completed in 2012 is shown below. It is understood that these surveys are still representative of equipment installed at sites for both networks:

- Scotland network: 52 off controllers across 20 offtakes/PRS/STRS
- Southern network: 127 off controllers across 17 offtakes/PRS

Key legislative compliance:

IGEM/TD/13 applies to the safe design, construction, inspection, testing, operation and maintenance of pressure regulating installations (PRIs).

Impact of losing asset:

Scotland. The majority of pneumatic controllers serve as backup in the case the electronic controller is to fail on site, however there are a number of STRSs where the pneumatic controller is the primary control unit for heating. These sites are based within Scotland and are as follows: Blanefield, Kemnay, Fallin, Newton Stewart, Plean, Priestdykes and Rhonehouse. If any of these sites were to lose control of heating, Gas control would need to stop flowing through that site until the issue was resolved.

The table below highlights the number of customers each site is connected to.

Table 10: Number of customers for Scottish STRSs

Site	No of customers
Blanefield	2,656
Kemnay	1273
Fallin	960
Newton Stewart	2,117
Plean	1,557
Priestdykes	776
Rhonehouse	2,996

As Rhonehouse STRS has the largest number of customers this site was used as a 'worst case scenario' if the site was to stop flowing due to a pneumatic controller failure. In this instance, the SGN Network Analysis team have provided the following information to continue delivering gas to these customers until the pneumatic control issue was resolved at Rhonehouse STRS.

Information provided by Network Analysis is that if Rhonehouse STRS was to be backed off, two sites which are Newton Stewart and Milton, both PRSs, would be able to provide gas to the customers of Rhonehouse, however this is only when peak demand is under 55%. This would however require that the district governor at 'Old Gas Lane' be monitored throughout the duration that Rhonehouse STRS is offline. During the winter months and when peak demand is over 55%, the surrounding network will not be able to supply the town of Rhonehouse, which would leave the customers without gas.

An analysis was also carried out for Broxburn Offtake which supplies a large number of customers within the Edinburgh area. Broxburn currently supplies gas to over 200,000 customers, therefore the criticality of keeping gas flowing through this site is paramount. Broxburn currently supplies 7 PRSs, which include Granton (City and Forth), Turnhouse, Fairmilehead, Bol-o-Bere, Winchburgh, Swanston, Straiton. Network Analysis have indicated that if the back-up pneumatic controllers were to fail, then supply to both Granton City/Forth and Fairmilehead would come to a halt. The number of customers that would be affected by this is 137,468. This would have an extensive impact on the public and therefore it is essential spares are held by SGN if and when needed.

During winter months SGN sites will struggle to cover the entire network if heating is lost and gas cannot flow through a site. This is apparent for both larger offtakes and smaller PRSs as per the Network Analysis results. It is therefore crucial that parts are available for both repair and overhaul services.

South and South East. Similarly, an analysis was also carried out at Farningham Offtake which also supplies an extensive number of customers. When demand is under 80%, offtakes Shorne, Tatsfield and Winkfield can accommodate Farningham. However, during the winter months and when peak demand is over 80% the surrounding network will not be able to carry the extra load. This has the potential to affect 499,619 customers.

8.5 LGT Refurbishment Programme

Background

SGN has a duty to ensure that gas transported on behalf of gas shippers via our integrated pipeline network is sufficiently odorised, so gas leaks can be detected and repaired.

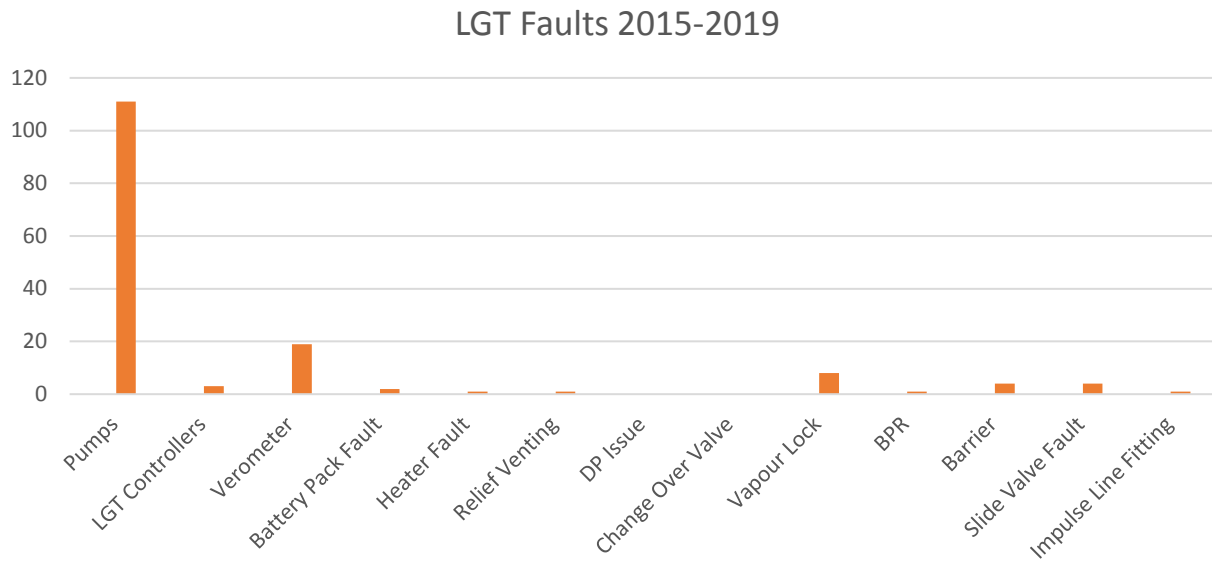
To ensure odorising requirements are met, it is essential we ensure reliable operation of our local gas treatment (LGT) plants.

It has been identified that over GD1, pump failures and alarms are an on-going issue. In addition, verometer faults while not regular have been occurring on a number of sites. Other issues are related to junction boxes, relief vents, I.S barriers and LGT cabinet corrosion have also been identified.

Scope of works

The following forms the scope of works for each site:

- Re-ranging of pumps - The recent upgrade programme has highlighted that several LGT installations are working outside of the manufacturer's recommendations. This is a mixture of systems that are stroking faster or slower than recommended.
- Refurbish power gas regulators - the power gas regulators and relief valves are old and at times failing.
- Re-design of vent stacks - the vent stacks are inadequately designed, they let water in which fills the relief valves and then can freeze leading to loss of power gas.
- New cable tray - the cable tray used for cable and impulse pipework support is bent and damaged, on some sites also shows signs of corrosion.
- The tank level instrument on top of the bulk odorant tank and associated junction box is original in some cases and is in a poor state of disrepair.



What is out of scope

Any sites which are planned for a full site rebuild or relocation due to integrity or network capacity issues, then the LGT systems will be replaced as part of the rebuild. Any cabling or equipment which is not in an un-operable condition, will be kept.

Faults

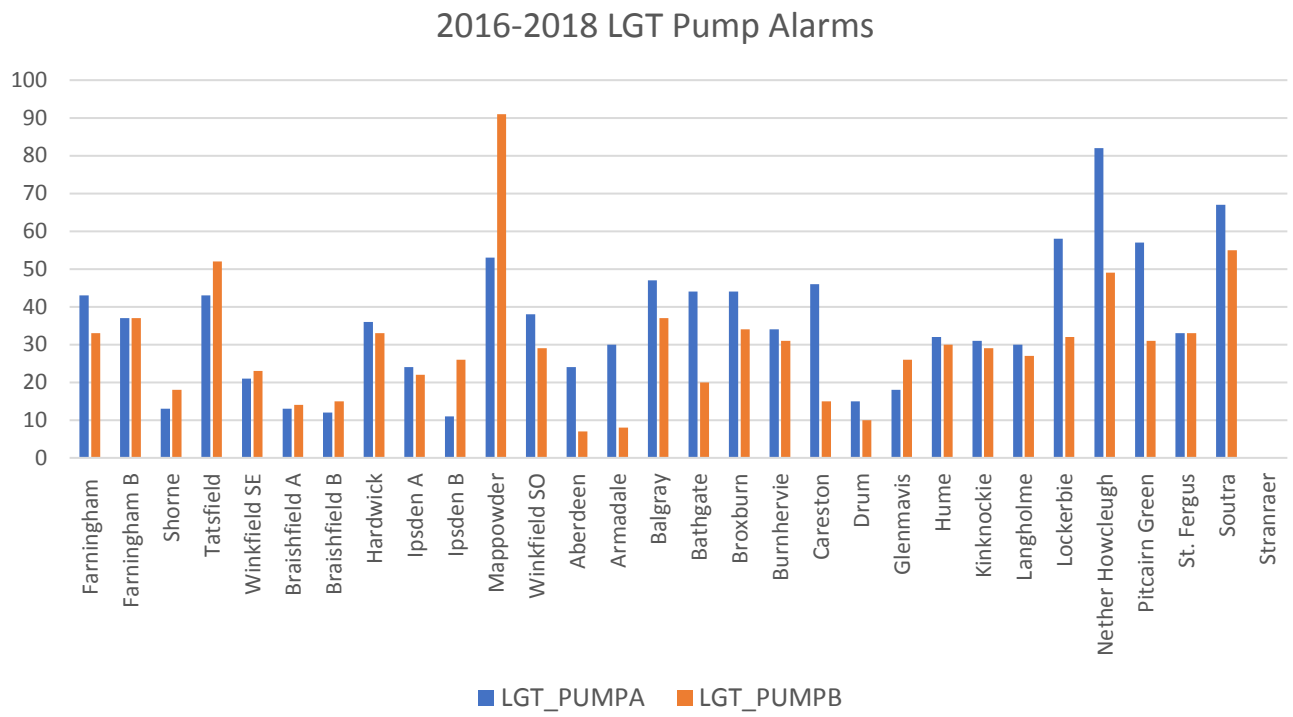
The data from 2015-2019, shows that the most common fault occurring is in relation to the pumps. This could be

due to the continued use of the pumps and the increase of wear and tear over a prolonged period of time. Nether Howcleugh has encountered 32 separate pump failures/vapor lock in that timeline. E&I operations have indicated that the pumps on this site are 15+ years old and would benefit from a pump upgrade.

Other pump issues have arisen from both under pumping and over pumping scenarios. While under pumping can be difficult to rectify due to the nature of low flow sites during summer months, over pumping is an issue which can be rectified by providing pump upgrades.

Orbital have indicated the recommended pump stroke rate should be within 3-70 seconds, outside of these ranges causes both under and over pumping leading to faults. At present there are several sites which fall under the 3 second mark if required to flow at maximum capacity.

Figure 10: LGT Pump Alarms 2016 - 18



Verometers

Verometer issues have also been reported which can be caused due to environmental temperature changes which causes the liquid within the verometer to expand/extract. This has proved problematic during low flow periods, where the stroke rate is above the recommended 70 seconds and the liquid within the verometer has time to expand.

Smaller scale faults

Other issues which have been identified by E&I Operations are in relation to corroded I.S barrier terminals and junction boxes. In addition, relief vents and valves have also suffered corrosion over time. Below is a sample of 7 incidents where corrosion has led to faults and callouts to site.

Table 11: Summary of Small Scale LGT Faults

Site	Date	Fault	Solution
Braishfield	25/04/2018	Water ingress into IS JB which corroded internal resistors	Replaced part
Tatsfield AGI	14/10/2015	Badly corroded IS JB	Replaced part
Tatsfield AGI	20/10/2015	Badly corroded terminals	Replaced part
Mappowder	21/10/2016	Corrosion on terminals inside field IS JB	Replaced part
Soutra	09/12/2017	Corrosion on terminals inside field IS JB	Replaced part
Soutra	12/12/2017	Badly corroded terminals in IS JB	Replaced part
Netherhowcleugh	05/11/2015	Relief valve RV101 failed to fire before 13bar during annual testing, set-point=10bar.	Passed to third party

Pump and Spacer Costs

We have identifed a number of sites where pumps should be upgraded due to them not being within the manufacturer's recommended guidelines and/or have received a significant number of faults and alarms. These pumps are currently running on the highest spacer capacity and can therefore only benefit from a pump upgrade.

Refurbishment Costs

As previously discussed in 'Smaller Scale Faults', we have had issues with corroding parts such as I.S barriers, junction Boxes, LGT cabinets, cable trays and impulse pipework. As this equipment is ageing and been exposed to environmental elements, it is essential that these parts are replaced before serious corrosion takes place and affects the functionality of the LGT system. While this has not caused 'major' issues as yet on SGN sites, these parts for several sites are now 15/20 years old and require replacement and refurbishment over the GD2 period.

Key legislative compliance:

As a gas transporter SGN is required under The Gas Act (1986), Gas Safety (Management) Regulations – 1996 GS(M)R, to odorise the gas that entering our local transmission system LTS at Offtakes and entry points.

SGN must comply with the Dangerous Substances and Explosive Atmospheres Regulations 2002 (DSEAR) which place duties on employers to eliminate or control the risks from explosive atmospheres in the workplace. Directive 94/9/EC (also known as 'ATEX 95' or 'the ATEX Equipment Directive') on the approximation of the laws of Members States concerning equipment and protective systems intended for use in potentially explosive atmospheres.

8.6 Glenmavis High Voltage Rationalisation Project

Background

Glenmavis was previously a National Grid owned and operated site, with an SGN Offtake located within the site compounds. National Grid had a high voltage infrastructure, and they imported and exported electricity to the grid.

In 2014, National Grid no longer required the site, and due to continuity of supply necessity, SGN purchased the site.

Due to a number of factors including reduction in opex costs, energy efficiency, competency and asset integrity, SGN now plan on rationalising the high voltage supply at Glenmavis offtake.

Figure 11: Glenmavis HV Distribution Equipment

Detailed description of the project

The objective of this project is to rationalise the high voltage supply and equipment at Glenmavis and move to a low voltage power supply.

SGN have investigated several options for the future electrical supply for the site which currently houses two PRSs and an offtake.

Options explored:

- Upgrade existing high voltage equipment and keep a high voltage supply. This was ruled out as it was the most expensive option, and a high voltage supply is surplus to our requirements.
- 2 other options were variants of a new low voltage supply from different locations. SGN have costed for connecting to an existing low voltage supply, which delivers our operational requirements and is also the lowest cost option.

The existing load demand required by the operational site is approximately 50KVA.

This is provided by the original LNG Storage H.V./L.V. distribution system which has a capacity of 2.1MVA; previously required by National Grid to supply their LNG storage facility.

As well as an opex savings from moving to a low voltage supply, this project removes a significant risk for SGN as high voltage equipment requires additional training/competence and routine maintenance. This will also result in the removal of oil filled transformers on site which could contain polychlorinated biphenyls (PCBs) which have a detrimental impact if exposed to the atmosphere and also require special handling/disposal requirements.

What is out of scope

Electrical system and equipment which forms part of the offtake/PRS will not be considered as these have recently been upgraded (2013).

Key legislative compliance

SGN must comply with the Electricity at Work Regulations 1989 to ensure safe systems of works are being implemented and to ensure electrical systems and equipment is adequality designed to ensure safe operation and maintenance.

8.7 Non-Telemetered Sites Work Programme

Background

Telemetry monitoring systems are pivotal to the management of gas network across SGN sites. In fact, 75 to 90 percent of faults across our sites are detected via telemetry. Recent surveys and analysis conducted by SGN have revealed that heating systems fail for various reasons, and when they do, the gas flowing downstream of the inlet pipework freezes because of reduction in pressure between the inlet and outlet pressure.

SGN currently manage sites without telemetry by periodically visiting sites with activities such as maintenance, site surveys / inspections, and information received from gas consumers experiencing no supply of gas.

Detailed description of the project

SGN has identified 14 sites with preheating (without backup power supply) that are not monitored via telemetry. Recent development in safety studies undertaken by SGN via Hazard and Operability study (HAZOP) / Layers of Protection Analysis (LOPA) have highlighted the risk of gas escape and loss of supply. Freezing of the gas pipeline could potentially result in a fracture of the pipeline if not addressed.

Due to the requirement to maintain gas flows through these sites especially when they are a single feed into a local distribution network it is essential we ensure continuity of supply. Failure of the heating system due to the Joules-Thompson effect will lead to potential freezing of the pilots and loss of supply.

The scope of this project covers the introduction of a telemetry system to 14 Pressure Reduction Installations (PRIs) within the GD2 programme. This will ensure that SGN conforms to the requirement of IGE/TD/13.

Figure 12: Typical Low Tier Pre-Heating Site

Scope of works

The following list of pressure reduction sites with preheating systems are proposed to be installed with new telemetry systems to provide remote monitoring of the site, with essential temperature and pressure indication. This will include a low-cost battery backed up telemetry system with communication and associated upgraded extra low voltage systems.

Table 12: Sites which form the Scope of Works

1)	**Chessington**	**2)**	**Ellens Green**	3)	**Etchinghill**
4)	**Fletching**	**5)**	**Freshfields**	6)	**Hawkhurst**
7)	**Henfield**	**8)**	**Herne Hill**	9)	**High Halden**
10)	**Smarden**	**11)**	**Ockley**	12)	**Partridge Green**
13)	**Peasmarch**	**14)**	**Petersfield**		

What is out of scope

No E&I consideration has been made for the current condition of the heating systems. This is a mechanical asset and this work will not include any preheating system upgrades for these sites.

Loss of asset

A high temperature excursion in pipework downstream of the preheat system exceeding the design temperature of the PRI equipment which has soft parts may lead to loss of containment of natural gas leading to potential fire or explosion. Likewise, a low temperature excursion in pipework downstream of the preheat system exceeding the low design limits of the pipework and equipment can stress the pipework leading to brittle fracture or frost heave damage. The ultimate consequence of this event will be loss of containment of natural gas leading to a potential fire, loss of supply or explosion (these are all based on expert elicitation).

Either low temperature or high temperature downstream of the preheat system could result in a catastrophic failure if not monitored correctly. The introduction of a telemetry system on site will reduce the risk of a potential hazard because of early warning indications/alarms caused by loss of heating or overheating the gas. An alarm response time of 2 hours is what is allowed for to respond to temperature faults onsite as documented in the management procedure for selection of telemetry points to operate the SGN Gas Supply System (SGN/PM/INE/3).

The Engineering Equipment and Material Users Association (EEMUA) publication '191 Alarm systems – a guide to design, management and procurement' has been adopted by SGN (SGN/PM/INE/3) to ensure that risks are as low as reasonably practicable.

Partridge Green is a PRI within the South East of England without a backup power supply which feeds approximately 800 households. It is the only supply to the village and has suffered frost heave in the past.

Key legislative compliance

SGN has a legal duty under Regulation 3 of Gas Safety and Management Regulations GS(M)R to prepare a safety case and have it accepted by the HSE to ensure safe management of gas flow through our network.

Under SGN/PM/INE/2, telemetry is essential to ensure supply demand management also allowing GCC to a centralised overview of the prevailing condition of the gas network with an associated response. These sites are required to be monitored over our Scada system due to the criticality of the site and the requirement for preheating. The existing electrical infrastructure on site will be refurbished to meet the requirements of the electricity at work regulation.

8.8 Cathodic Protection TR Replacement Programme

Background

To ensure a high level of safety and reliability in operation, it is essential that buried steel pipework associated with the transmission and distribution of natural gas is designed, installed and commissioned, to withstand the potentially harmful effects of corrosion and those corrosion control systems are monitored to ensure continued effectiveness. Our steel pipelines are normally protected against corrosion by impressed current cathodic protection schemes utilising electricity transformer/rectifier installations and ground beds located at suitable locations to achieve optimum system effectiveness.

A conventional impressed current CP system utilises a single-phase 230V AC supply to energise a transformer/rectifier (T/R). Where such a power supply is not available, but all other factors are favourable, solar, thermoelectric or wind power sources can be used. The T/R units include internal timers, facilities to install remote timers for Close Interval Protection (CIP) surveys, meters and circuit protection. The procedure states that all equipment should be accessible from ground level and should be housed in lockable enclosures to prevent interference by, or hazard to, livestock and unauthorised persons.

The SGN network has a total of 370 transformer rectifier installations, some of which are located on existing operational sites while others are stand-alone installations located along pipeline routes. The following table indicates the various type of installations to be found in SGN.

Table 13: SGN CPTR Locations

Site Location	Total Sites	Operational Sites	Stand-alone Installation			
			Total	Pole Mount	GRP Kiosk	Concrete Kiosk
South LDZ	116	20	96	27	39	30
South-East LDZ	121	47	74	6	35	33
Scotland LDZ	133	18	115	5	110	
Network Total	370	85	285	38	74 + Scotland	63 + Scotland

A significant number of the stand-alone installations are pole-mounted cathodic protection systems only accessible by ladder, at times difficult to access, and located on questionable surfaces, placing SGN personnel at risk during maintenance and inspection visits. Most of the installation's pre-date the 1990s, some still retain their original Mapel or Davenset rectifiers which have reached end of life, the equipment housings are at varying stages of deterioration, which is not to be unexpected considering the environment in which they are located.

Figure 13: Existing Pole Mounted TR's

What is in scope

Due to the age, obsolescence, electrical compliance and access requirements, our existing infrastructure of cathodic protection systems across our networks requires improvement. Our proposal is to have a rolling programme to remove and replace our most critical installations and bring them up to current standards,

installing them in ground mounted GRP enclosures. The deteriorating condition of concrete T/R housings now also gives cause for concern as they are the primary barrier to prevent weather ingress and potential for unintentional electrical shock contact.

This paper is therefore primarily focused on the essential upkeep of stand-alone T/R installations and seeks an annual budget allocation to continue with that programme. Replacement costs are estimated at £13,255 per installation, based on recent project costs.

What is out of scope

Those installations located on SGN operational sites tend to be in more beneficial environments and require less frequent maitenance, any replacement normally only occurring as a direct result of site upgrade or electrical failure of the equipment itself.

CP ground-beds are not considered in this Paper as they do not form part of the Electrical & Instrumentation department's responsibility.

Key legislative compliance

SGN Policy Document SGN/PM/ECP/2 - Management Procedure for Cathodic Protection of Buried Steel Systems – provides guidance on such work. The document requires all existing buried steel mains operating at pressures >2bar to have an effective CP system installed and recognises that the continued effective operation of such a CP system is totally dependent upon a satisfactory level of monitoring and maintenance, and that forms an essential part of the overall pipeline management system.

All new and existing electrical installations must comply with the requirements of BS 7671 providing adequate protection against the environment and ensure compliance to 'The Electricity at Work regulation 1989'.

8.9 Gas Chromatograph Replacement Programme

Background

As a gas transporter SGN is required to determine the quality of gas as energy conveyed to each consumer. The energy is determined as the product of volume, and the Calorific Value (CV). In some cases, the CV is determined specifically for the consumer, or determined for a charging area that corresponds with the SGN gas transportation boundary.

Currently, the only Ofgem approved instruments able to provide the required levels of accuracy of CV measurement are the Gas Chromatographs and Gas PT's. These instruments are also capable of very accurate and comprehensive analysis of the composition of the constituent gases, and thus include the ability to monitor gases for ensuring compliance with the Gas Safety (Management) Regulations 1996, Schedule 3 requirements.

The Daniels 500 model chromatographs will be deemed obsolete and unsupported from 2020 and there has been a significant rise in number for faults recorded by our E&I operations team with regards to the Daniels 500 chromatograph.

What is in scope

The following Calorific Value Chromatograph systems used across SGN sites:

- Daniels 500 – obsolete from 2020, and installed in the 90s with the move to Flow Weighted Average Calorific Value (FWACV)
- Emerson 700 – now classed as "mature" (end of working life)
- Emerson 370XA – 15 years life expectancy
- Elster Encal 3000 – 15 years life expectancy
- GAS PT2 – Used on SGN Tracker sites in Scotland

Table 14: Sites with Daniels 500 GCs

Southern Network	Scotland Network
Shorne	Bathgate
Farningham B	Burnhervie
Braishfield	

The scope of this workstream is to replace the remaining Daniels 500 GCs with approved devices such as Emerson's 370XA, Orbital Gas PT and Honeywell EnCal 3000.

Daniels 500 GC

Emerson 370AX GC

What is out of scope

This work package will not involve replacing other Gas Chromatographs SGN currently operate such as Emerson 700's which are largely used at Bio Methane sites or Gas PT2's which are used at SGN tracker sites in Scotland as those specific systems will still be supported through the GD2 price control period and beyond and do not show any signs of degradation.

Key legislative compliance

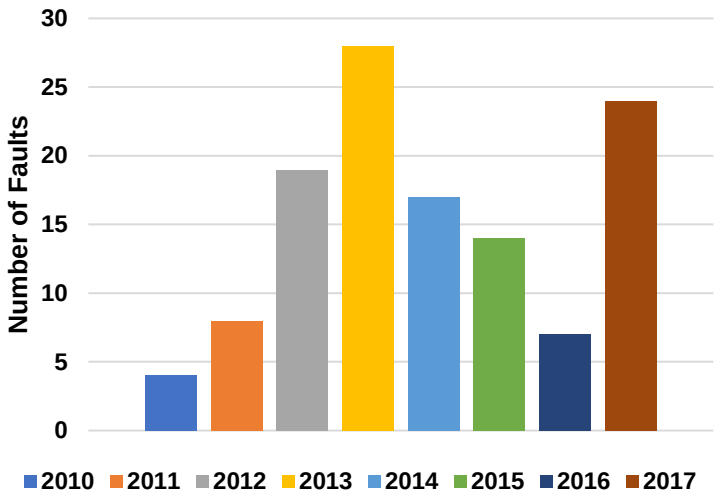
As a gas transporter SGN is required under The Gas Act (1986), Gas Safety (Management) Regulations – 1996 GS(M)R, and The Gas (Calculation of Thermal Energy) Regulations 1996 to determine the quality of gas as energy conveyed to each consumer. The energy is determined as the product of volume, and the Calorific Value (CV). In some cases, the CV is determined specifically for the consumer, or determined for a charging area that corresponds with our Gas Transportation boundary.

Impact of losing asset

The GC is a crucial piece of kit SGN must continue to maintain. As the equipment is crucial to the fiscal element of the company, we are required to obtain accurate readings to remain GS(M)R compliant.

If the GC was to fail at any SGN site, that site would be required to stop flow as SGN would no longer be compliant with GS(M)R regulations. As a gas transporter SGN are obliged under statute, licence conditions and Uniform Network Code for the management of the quality and quantity of gas conveyed on its Network, document 'SGN/PM/GQ/8' highlights the legal requirements which must be met. We will be liable to fines/penalties if failure to meet GS(M)R regulations occurs.

Figure 14: GC 500 Fault Records for Daniels 500 Chromotographs



An analysis was carried out for Broxburn National Offtake which currently supplies gas to approximately 150,000 customers, therefore the criticality of keeping gas flowing with accurate energy readings through this site is paramount. Broxburn currently supplies 7 PRSs, which include Granton (City and Forth). Turnhouse, Fairmilehead, Bol-o-Bere, Winchburgh, Swanston, Straiton.

This would have an extensive impact on the public and therefore it is essential that the GC at all sites are regularly maintained with associated spare parts available.

Similarly, an analysis was also carried out at Tatsfield offtake which also supplies to an extensive number of customers. When demand is under 83%, offtakes Shorne, Farningham A & B and Winkfield can accommodate Tatsfield. However, during the winter months and when peak demand is over 83% the surrounding network will not be able to carry the extra load. This has the potential to affect 424,676 customers.

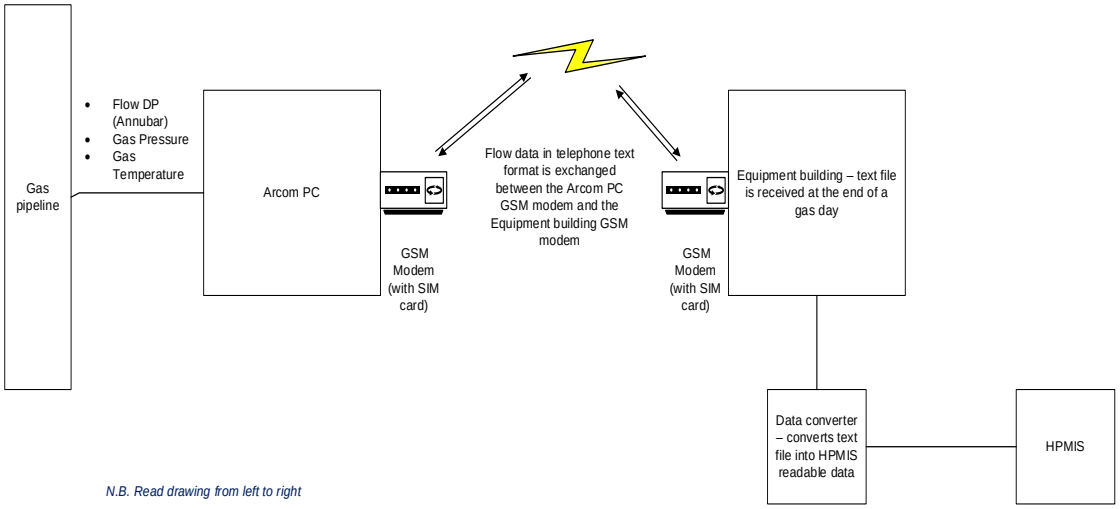
8.10 Inter LDZ Metering Replacement Programme

Background

SGN as a gas transporter has an obligation under the Uniform Network Code (UNC) which is a requirement common to all gas transporters to provide Local Distribution Zones (LDZ) with gas flow/demand data.

SGN have four Local Distribution Zones (LDZ) metering sites installed circa 2008 which are used to determine the flow, and quality of gas coming into our network. For this reason, the Office of Gas and Electricity Markets (Ofgem) requires SGN to monitor the gas Calorific Value (CV) entering or transferring between networks.

Figure 15: Block Diagram of Inter LDZ Configuration



Scope of works

The scope of this project covers the replacement of Ofgem noncompliant gas analysers (now obsolete) across the 4 sites identified. It also covers replacing and/or refurbishing associated Electrical and Instrumentation (E&I) assets which include flow computers, communication into supervisory control and data acquisition (SCADA) and High-Pressure Meter Information System (HPMIS), battery systems, power supply units, and GRP kiosk.

Table 15: SGN Four Inter LDZ Sites

S/N	Transfer "from" LDZ	Transfer "to" LDZ	Site name
1	North Thames (NT)	South East (SE)	Oak Lane
2	North Thames (NT)	South East (SE)	Blackmore Crescent
3	North Thames (NT)	South East (SE)	Dryburgh Road
4	Northern (NO)	Scotland (SC)	Lamberton Toll

An additional 4 sites have been identified to have similar arrangement as the sites listed in table 28. SGN wishes to collect, analyse, and record data in line with the existing UNC arrangements and Ofgem requirements as previously mentioned. These 4 sites are shown in table 15.

Table 16: Additional 4 Inter LDZ sites

S/N	Transfer "from" LDZ	Transfer "to" LDZ	Site name
1	South East (SE)	East Anglia (EA)	Cranfield
2	South East (SE)	North Thames (NT)	Dolesen
3	South East (SE)	North Thames (NT)	Ascort Terminal
4	South East (SE)	North Thames (NT)	Dunstall Green

The equipment listed in the table below have been identified as obsolete and not fit for purpose. In addition to this list, additional defects might be addressed subject to findings during project work.

Table 17: Equipment Description on Inter LDZ sites

S/N	Units affected	Justification
1	Gas PT 1	The Gas PT 1 is now obsolete and Ofgem does not consider it good practice to continue to use arbitrary and historically unsupportable parameters for approving gas CVs. Ofgem consider it better practice to align its approval parameters to internationally accepted Calorific Value Determining Devices (CVDD) accuracy tolerance levels.
2	Arcom PC with GSM Module	Now obsolete and no longer supported by the manufacturers. Failure of this equipment will lead to loss of data and inadequate billing. A new telemetry system will ensure that real time data is captured.
3	Power Supply Unit (PSU)	The PSU and batteries on the equipment is located within street furniture and is subject to wear and tear. The gas analysers require a stable PSU to function correctly.

Figure 16: Inter LDZ Site - Kiosk, Gas PT, Flow Equipment and Comms Equipment

What is out of scope

Existing kiosk will be surveyed to determine the requirement for replacement/refurbishment. Pressure and temperature transmitters will be reutilised. Battery chargers will be reviewed depending upon new system requirements.

Key legislative Compliance

- Under the Uniform Network Code SGN has an obligation to provide end of day mass flow data at custody transferred sites between distribution networks.
- Compliance to the electricity at work regulation.
- As a gas transporter SGN is required under The Gas Act (1986), Gas Safety (Management) Regulations – 1996 GS(M)R, and The Gas (Calculation of Thermal Energy) Regulations 1996 to determine the quality of gas as energy conveyed to the consumer.
- SGN must comply with the Dangerous Substances and Explosive Atmospheres Regulations 2002 (DSEAR) place duties on employers to eliminate or control the risks from explosive atmospheres in the workplace. Directive 94/9/EC (also known as 'ATEX 95' or 'the ATEX Equipment Directive') on the approximation of the laws of Members States concerning equipment and protective systems intended for use in potentially explosive atmospheres.

8.11 Metering Uncertainty Programme

Background

In preparation for the RIIO-GD2 Business Plan, SGN have carried out an independent metering review using independent metering experts Kelton Engineering Ltd to produce a detailed fiscal metering technical report. The report will be submitted as an appendix, technical supporting paper for our existing fiscal metering offtake pressure reduction sites. The gas flow metering systems on these offtake sites are vitally important for correct Ofgem approved fiscal custody transfer of the gas flow from the National Transmission system operated by National Grid and correctly odorising the gas as part of an integrated Flow Weight Average Calorific Value (FWACV) system into the downstream distribution network.

The metering review considered the potential of installing summer/winter meter streams at certain NTS to LDZ offtakes which have been directly affected by Biomethane Network Entry Facilities (BNEFs). The addition of these new biomethane sites to the local network into which the existing offtake sites operate to maintain either volume or pressure control of downstream gas network, have during the summer months caused the offtake to be backed off from flowing gas into the downstream network from the transmission system.

The existing offtake metering systems were not designed to operate with these additional sources of gas to the local downstream network with subsequent very low flow across the metering system. As a consequence, the metering system uncertainty of measurement required by Ofgem cannot always be guaranteed to remain within tolerance at very low flows typically at night in the summer. This also affects the accuracy of odorisation as the stenching system needs to operate on default settings in these low flow conditions where the meter system readings may be infrequent.

Existing systems installed have a limited ability to cope with such a wide range of flow rate and as such need to be matched carefully to expected flow rates to achieve the accuracy of measurement required. Newer meter systems such as Ultrasonic metering (USM) are better able to cope with a wider range of flow rates without exceeding uncertainty of measurement tolerances. As a direct result of experience gained since biomethane sites started to be added to the distribution network in 2014, we have carefully considered if there is a cost benefit for upgrading offtake metering sites that were not upgraded during RIIO-GD1, looking at the options to reduce metering system uncertainty and improving gas measurement accuracy for our low flow sites.

During the mid-90s with the restructure of the gas industry and the move to regional charges for gas energy around 1995, there was a requirement to upgrade the metering installations and incorporate the requirements of the Gas (Calculation of Thermal Energy) Regulations 1996 and incorporate the process of “direction” followed by Ofgem.

The upgrades to the existing metering system involved the installation of a new discrete mass gas flow computer system which calculated mass flow of the gas using a recognised standard equation and calculations based on the differential flow across an orifice plate to the BSEN 5167 1991 metering standard. The upgrade also included installation of Ofgem approved Gas Chromatographs for gas composition analysis and an integrated supervisory computer software system to manage the daily data handling.

There were no physical changes undertaken on the orifice plate installations or secondary instrumentation as part of these upgrades and this resulted in agreed metering system measurements uncertainties of +/-3.5% between 0-30% and +/-2% from 30% to 100% of flow. These uncertainties limits are detailed in the Unified Network Code supplemental agreements for each offtake.

These metering systems were then identified by Ofgem as needing to be replaced or upgraded where there is a significant business risk due to the asset reaching the end of its useful life. The installation of an USM metering system will provide improved uncertainly values of +/- 1% volume and +/- 1.1% energy, meeting our commitment to Ofgem.

Ultrasonic meter systems correctly sized can accommodate a wider range of gas flows than an orifice plate system without changing any physical part of the meter. This allows an Ultrasonic metering system to improve

measurement accuracy at low flows without materially changing any major components reducing opex costs.

With the existing metering systems such as Orifice plates there is a greater potential to reach noncompliance of the measurement uncertainty at the bottom end of the system measurement range below 10% due to the measurement system relying on differential pressure which falls off at low flow conditions. Experience has demonstrated that low flow will become a more frequent occurrence when Biomethane sites join the network.

SGN proposes within RIIO-GD2 to continue its programme to upgrade and replace our existing fiscal metering offtake sites. This proposal considers the improved metering uncertainties that can be achieved by installing ultra-sonic metering, considering low flow sites that consistently flow below 10% demand with higher metering uncertainties. Our independent review has considered the benefit of improving our metering assets on these sites to ensure continuity of gas supply and odorant injection rates.

The proposed new USM metering systems have inbuilt diagnostic capability and increased scope for condition-based monitoring of the measurement system with earlier warning of problems possible. The USM meters have multiple path sensors providing an improved measurement certainty across the meter and gas path. Flow conditioners have also been added to further improve the uncertainty of measurement possible and thus provide improved accuracy of the overall system.

What is in scope

SGN have looked at metering uncertainty, low flow cut off and installation of summer/winter streams affected by biomethane injection sites. Consideration of asset condition, risk of metering errors and opex costs have also been considered. Where appropriate an additional appropriately sized summer USM metering stream may be added to improve metering and odorisation accuracy during lower flow conditions experienced during the summer months.

Table 18: Sites in Scope of works

Site	Recommendation	Justification
Armadale	Use Summer-Winter plates	Reduced uncertainty and commercial exposure; Payback ~3 months
Kinknockie	Upgrade to 2 x 4” USM	Potential impact of BNEF flows from Downiehills Farm and Foveran Biomethane sites. Non-Conformance with Supplemental Agreement; Reduced uncertainty and commercial exposure; Payback ~12years.
Soutra	Reduce low DP cut-off	Potential under-odorisation; Recovery of unregistered gas
	Upgrade to 2 x 4” USM	Reduced uncertainty and commercial exposure; Payback 12 to 16 years
St Fergus	Capacity driver - Upgrade to 2 x 3” USM NB consider potential to be affected by Hydrogen project	(No BIO site connected to this leg). Non-Conformance with Supplemental Agreement. Cannot provide 100% of site flow with one stream.
Careston	Upgrade to 2 x 8” USM	Non-conformance with Supplemental agreement; Reduced uncertainty and commercial exposure; Payback ~16 years
Langholm	Upgrade to 2x2” USM	Potential impact of BNEF flows; Non-conformance with Supplemental agreement; Reduced uncertainty and commercial exposure.
Mappowder	Upgrade to 2 x 8” USM	Reduced uncertainty and commercial exposure;

To ensure that process was robust SGN instructed Kelton Engineering to review each site, collect data for current site gas flows, predicted future site gas flows, and sites affected by biomethane network entry facilities from SGN Network planning. Kelton also carried out network modelling work and made recommendations.

The sites are ranked as follows:

- By safe and reliable network for those sites that have the greatest potential for a significant metering error being realised.
- Opportunity for those sites which would benefit from an upgrade for reasons already stated but may not have significant potential for a metering error to cause large commercial exposure due to lower usage.

What is out of scope:

Table 19: Out of scope sites

Site	Recommendation	Justification
Shorne	No upgrade	Not used sufficiently; Well controlled. Contingency for IOG mothball or decommission in GD2

Key legislative compliance

- SGN has a legal duty under Regulation 3 of Gas Safety and Management Regulations GS(M)R to prepare a safety case and have it accepted by the HSE to ensure safe management of gas flow through our network.
- The Uniform Network Code (UNC) comprises a legal and contractual framework to supply and transport gas. It has a common set of rules for all industry players which ensure that competition can be facilitated on level terms. Under the UNC, SGN must provide National Grid Transmission (NTS) with certain real-time data about gas flows and demand within the SGN network.
- The requirements of the Gas (Calculation of Thermal Energy) Regulations 1996
- BS7965 Guidance on the selection, installation, operation and calibration of diagonal path transit time gas ultrasonic flowmeters for industrial gas applications.

8.12 Electrical, Instrumentation and Control Replacement Programme

Background

SGN have put forward a number of operational gas sites which require upgrade and refurbishment work to our electrical, instrumentation and control equipment and systems.

A number of our electrical isolators contain asbestos as this material was used within fused switchgear, fuse boards or behind ceramic fuses and a lot of older electrical isolators do not allow equipment to be safely isolated using SGN Safe Isolation Procedure.

On SGN older sites a lot of the equipment was installed pre-ATEX, and as a result we are noncompliant with ATEX/DSEAR and there is considerable remediation work to be done.

In 2018, SGN commissioned the Health and Safety Laboratory to carry out an electrical safety gap analysis, and below is one of their observations, which SGN aim to close in GD2:

"While most modern SGN sites have rotary double pole isolation which is the easiest to lock off quickly, at some sites there are a number of older isolation devices which do not lend themselves to easy lock off in spite of the wide range of adaptors available in the lock off kit provided to staff."

Figure 17: Asbestos containing distribution kit at Soutra Offtake

What is in scope

E, I &C equipment which does not form part of a mechanical site rebuild or support mechanical component upgrades such as gas preheating systems.

The sites which have been targeted have been derived from fault form returns, results from annual maintenance regime, E&I site surveys, electrical inspection and test result sheets and operational feedback. Smaller scale projects have been targeted under the integrity budget in section 5.

What is out of scope

E, I&C equipment which is to be upgraded as part of mechanical led component upgrade programmes or site rebuilds.

E&I Systems and equipment which are targeted within other outputs in the GD2 business plan.

Key legislative compliance

SGN must comply with the Electricity at Work Regulations 1989 and the Dangerous Substances and Explosive Atmospheres Regulations 2002 to ensure safe systems of works are being implemented and to ensure electrical systems and equipment is adequately designed to ensure safe operation and maintenance of their kit.

8.13 Instrumented Safety System Compliance Programme

Background

In the South-East of our network, SGN currently have fourteen sites with legacy instrumented safety systems. These systems comprise of a sensing pressure switch on the stream outlet manifold to the site. Through a relay, this switch energises a solenoid valve actuating a Kinatrol unit to fire the slam shut. During our GD1 period these systems have been assessed and deemed as a safety integrity level (SIL 1) functional safety system as this provides the primary protection under IGEM TD/13 for the site.

During the GD1 period we have started a programme to replace the sensing pressure switch and actuating solenoid for devices with higher reliability inside standalone cabinets. We are also in the process of implementing the requirements of BS EN 61511 to ensure we manage, maintain and assess these systems throughout their lifecycle, this has included the implementation of a generic proof test procedure for these sites.

Figure 18: Instrumented slam shut compliance issues

What is in scope

Our proposal within GD2 is to ensure we comply to the requirements of BS EN 61511, ensuring our systems are assessed and maintained to this standard. Historical systems at SGN require further identification and supporting records to minimise the gap.

Carrying out the above will ensure SGN meets the requirements of BS EN 61511

What is out of scope

No further consideration has been made for the replacement of the slam shut systems for a purely Gasmatic impulse TD/13 compliant system. This project is to ensure the reliability/operation of the existing system is maintained and available on site.

Key legislative compliance

- Should meet the requirements of BS EN 61508, *Functional safety of electrical/electronic/programmable electronic safety related systems* and BS EN 61511 Safety instrumented systems for process industry sector.
- IGEM/TD/13 applies to the safe design, construction, inspection, testing, operation and maintenance of pressure regulating installations (PRIs). SGN/PM/MAINT/2 PT3 Management Procedure for maintenance of pressure reduction installations with inlet pressure above 7 barg.

8.14 Industrial & Commercial Metering Data Loggers

The majority of our current Metretek GSM24 AMR devices were installed 10 years ago, prior to GD1, and have since been discontinued. In order to manage gas consumption across the network, it is essential we replace faulty devices and achieve aggregate targets set by the Central Data Service Provider Committee.

In 2018, engineers attended 1738 faults across both Scotland and Southern networks. Around 5% of these faults resulted in full replacement of the hardware on site. This project will find a solution to the obsolete hardware and software allowing for continued data output, while also aiming to reduce the number of faults being attended through the installation of new and more reliable devices.

Detailed description of the project

This workstream aims to address the ageing AMR assets within SGN.

Our AMR portfolio is essential to allow us to develop End User Categories and Demand Models of the gas network. AMR devices across eight gas consumption bands provide us with daily demand data which assists decisions relating to; Security of Supply, PRI capacity requirements, Bio-Methane Capacity Studies, seasonal contract / nexus Enquiries, mains replacement analysis, reinforcement analysis, connections enquiries, Network Validation, MOD 390 annual reviews. In short, the data provided is critical to most investment decisions on the network.

Our current supplier of AMR devices has discontinued production and therefore supply of the equipment is extremely low. Furthermore, most units currently installed are approaching the end of their asset life and are due for replacement as they were initially installed prior to GD1. This project will look to address these supply issues and replace faulty assets to enable us to improve performance against aggregate AMR portfolio targets.

What is in scope

To ensure continued meter read availability, SGN will be looking to steadily replace our current AMR portfolio with newly procured equipment. To undertake this replacement programme, investment will also be required to upgrade and change our current support software.

What is out of scope

The Central Data Service Provider (CDSP, commonly referred to as Xoserve), has recently approached all the gas distribution networks regarding the potential for them to take on AMR portfolio management as a service provider. At this point in time, Xoserve has been unable to present in any detail the costs or scope of this service and so we have been unable to assess whether this would be an option which would be taken by SGN in the future.

Key legislative compliance

The Uniform Network Code (UNC) comprises a legal and contractual framework to supply and transport gas. It has a common set of rules for all industry players which ensure that competition can be facilitated on level terms. Under the UNC Transportation Principle Document, Section H specifically refers to SGN obligations to obtain data at Supply Meter Points comprised of Non-Daily Metered (NDM) Supply Points. As a result, SGN has installed and operates remote meter reading equipment to fulfil this obligation and shares the data with the CDSP.

8.15 E&I Minor Repair Works Programme

Background

This minor works programme is to ensure replacement of defective components, and to ensure a 'low regret' strategy to integrity repair issues.

There is an ongoing requirement for SGN Network E&I to respond to E&I equipment asset integrity issues reported/arising on offtakes and PRSs which are out of the scope for opex maintenance budgets and do not form part of larger GD2 programmes of work.

These are limited to smaller projects where on condition replacement of E&I assets are required which cannot be repaired due to poor condition e.g. severe corrosion, kiosk deterioration, equipment failure damage due to lighting strikes etc.

E&I operations annual maintenance programme is the main source for reporting these types of faults. E&I fault forms and E&I CM4 surveys will allow SGN to identify large scale programmes of works. As reporting regimes are being improved it is expected that there will be an increase in the number of smaller projects required during GD2.

Figure 19: Corroded Comms Kiosk and Up and Over Kiosk

Scope of Works

The projects covered would typically include the following, but this list may not be exhaustive.

- Replacement of individual failed instruments.
- Replacement of dilapidated fibreglass cabinets and kiosks which cause leaks onto E&I equipment.
- Replacement of obsolete fire and gas detectors providing alarms for safety mitigation.
- Replacement of unsafe electrical equipment that cannot be repaired.
- Replacement/repair of functional safety equipment that has failed.

What is out of scope

The majority of known obsolete/unsupported equipment and equipment with known faults have been identified in the GD2 strategy under the larger scale programme of works. It is envisaged this budget will be used to cover small scale works with a budget smaller than £30k because of asset failure due to unforeseen or unpredictable circumstances.

Key legislative compliance

Under the Electricity at Work Regulations, SGN have an obligation to ensure its electrical systems and equipment are in a safe condition to operate and maintain and not put anyone in harm's way. SGN also have an obligation to comply with the IET Wiring Regulations (BS7671:2018).