Engineering Justification Paper

Metering Uncertainty Programme

Final Version

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2 Introduction

This paper sets out SGN's investment proposal relating to the installation of flow metering at some offtake sites.

SGN consider that installing upgraded meter streams is necessary at certain NTS to LDZ Offtakes which have been directly affected by Biomethane Network Entry Facilities (BNEFs). Additionally, SGN are keen to explore if there is a business case for upgrading some Offtake sites that were not upgraded during RIIO-GD1 and look at the options to reduce site Gas Flow meter system measurement uncertainty for some of the other low flow sites.

The Offtake sites which have been completed and/or are to be completed as part of GD1 are listed in table 1 below.

Table 1: GD1 Meter Upgrade Summary

Site Name	LDZ	Budget	Status
Drum	Scotland	£1,750,000	Complete
Aberdeen	Scotland	£1,515,000	Site Construction Stage
Glenmavis	Scotland	£1,454,000	Site Construction Stage
Broxburn	Scotland	£1,569,000	Site Construction Stage
Farningham	South East	£1,900,000	Design Phase
Hardwick	South	£1,835,000	Design Phase, Tender Stage
Winkfield	South East	£1,900,000	Design Phase, Tender Stage
Tatsfield	South East	£1,750,000	Complete
Total		£13,673,000	

This report reviews the metering at 13 NTS to LDZ offtakes and provides a cost-benefit analysis of various upgrade options. Based on this analysis recommendations have been made for each offtake as summarised in Table 3.

2.1 General Background

This will be a continuation to the metering upgrades which have already taken place, or which are to be completed as part of GD1. SGN have upgraded several Offtake sites with newer Ultra Sonic Meters (USM) which provide higher efficiency and accuracy when compiling metering data. This will help to reduce significantly the uncertainty of measurement of the flow meter system.

The uncertainty of a measurement is the level of doubt in an instrument. No measurement device can provide a true value of quantity but rather an estimated value. In effect it is an evaluation of the quality of the measurement. This considers the type of meter, flow conditioning, maintenance of the meter and secondary instruments (DP Transmitters) if the device is an orifice plate.

2.2 Site Specific Background

The Offtake sites mentioned above which have not yet been upgraded are currently conforming to ISO 5167:1991 standards (Measurement of fluid flow by means of pressure differential devices inserted in circular cross-section conduits running full) however once the USM upgrade has been completed the sites will then confirm to ISO 17089:2010 (Measurement of fluid flow in closed conduits- Ultrasonic meters of gas)

There are numerous drivers for upgrading the metering system and various options that can be considered to address these:

- Safety - Under-odorisation may lead to undetected gas leaks whereas over-odorisation may lead to an increase in public reported escapes (PREs).

- Commercial - Measurement with high uncertainty may result in large losses or gains in financial terms and may also lead to an increase in network Shrinkage.
- Operational - Control of the system may be difficult when operating at low flow rates with high uncertainty or no visibility (i.e. below low DP cut-off). Upgrading the metering system can also improve reliability, availability and redundancy.

3 Equipment Summary

The sites below are requiring metering upgrades during the GD2 period. Table 2 highlights the current metering systems and equipment on each site.

Table 2: Table 1 GD2 Metering Equipment Summary

Site	Metering Details
Armadale	Armadale has a single 6"orifice plate metering stream using Yokogawa EJA110A DP transmitters (50 and 500 mbar range for low and high respectively), Honeywell STG170 pressure transmitter (80 barg range) and Class A Pt100 4-wire PRT for temperature measurement.
Careston	Careston has a single 12"turbine metering stream using a Rosemount 3051S1CG4A pressure transmitter (10 barg range) and Rosemount 248 temperature transmitter with Class A Pt100 PRT.
Kinknockie	Kinknockie has two parallel (2 x 100%) 8"turbine metering streams using Rosemount 3051S1CG5A pressure transmitters (80 barg range) and Rosemount 248 temperature transmitter with Class A Pt100 PRT.
Langholm	Langholm has a single 2"turbine metering stream using a Rosemount 3051 pressure transmitter (80 barg range) and Class A Pt100 PRTs. The site design capacity is 0.034 MSm3/d or 1,417 Sm3/h. The turbine meters were calibrated between 20 and 100 m3/h at a pressure of 49 barg. The low frequency cut-off is set to 3% of site capacity. Below this point the site is set to use a default odorant injection rate of 1%.
Mappowder	Mappowder has a single 12"orifice metering stream using Honeywell STD120 DP transmitters (100 and 600 mbar range for low and high respectively), a Honeywell STG170 pressure transmitter (80 barg range) and a Class A Pt100 PRT.
Soutra	Soutra has a single 6"orifice metering stream using Honeywell STD120 DP transmitters (50 and 500 mbar range for low and high respectively), a Honeywell STG170 pressure transmitter (80 barg range) and a Class A Pt100 PRT.
St Fergus	St Fergus has two parallel (2 x 100%) 4"turbine metering streams using Rosemount 3051S1CG5A pressure transmitters (80 barg range) and Class A Pt100 PRT.

4 Problem Statement

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

As a Gas Transporter SGN is required under The Gas Act (1986) & Gas Safety (Management) Regulations – 1996 (GSMR), to provide accurate billing for conveyance of gas in the distribution Network.

As demand changes over time, the flow range of the metering system can become unsuitable (too low or too high) for accurately measuring the quantity of gas entering the network. If the flow range of the metering is too high for the demand this can lead to increased measurement uncertainty or unmetered gas. If the flow range of the metering is too low for the demand this can lead to failure or saturation of the metering equipment and hence under-registration of gas. Under registration of gas leads to inaccurate billing, whilst exceeding uncertainty limits would mean ISO 5167 standards are not adhered to.

New biomethane sites entering the downstream network have potential to reduce flow through the offtake sites in the summer months which the existing metering systems were not designed to cope with for extended periods. This will increase the time where the existing metering system will be measuring gas below its optimum design flow rate, leading to an increase in the uncertainty of measurement for gas flow through the site.

On some sites in the South it is possible to close the site off for the summer period due to network configuration changes, however this is not always possible in Scotland where often the offtake is supplying the rest of the national region and cannot be closed.

More biomethane sites are being added to the Networks each year. This additional gas injection into the downstream distribution network is on the increase. If SGN does nothing in the next price control period to remedy this the overall accuracy of the Distribution Network metering system will be slowly eroded as more offtake metering systems will operate for longer periods below their minimum intended optimum design flow rates. This increase in measurement uncertainty will lead to greater commercial exposure and have potential for non-conformance with the Offtake Supplemental Agreements.

What is the outcome that we want to achieve?
Gas enters the distribution networks from the National Transmission System at various strategic points referred to as Offtakes. The measurement of the quantity of gas entering the network at each Offtake forms part of the calculation of the flow-weighted average calorific value process and is critical for accurate billing.

Maintenance of existing metering systems technology is often labour intensive and intrusive, requiring a multi skilled team on site to achieve changeover of metering system critical components e.g. Orifice Plates. To achieve accurate billing, the continuous upgrading and maintenance of the metering system throughout the Network is vital.

SGN wants to achieve a Network metering system which is compliant with both statutory and industry legislation, that delivers the necessary accuracy of measurement with the minimum maintenance requirements where appropriate, to satisfy our future needs.

How will we understand if the spend has been successful?
The spend will be a success when accurate metering of gas across the entire flow range and billing to customers is realised. Furthermore, when the risk of exceeding uncertainty limits is highly reduced and faults in relation to this are minimised to reduce maintenance and operational costs.

4.1 Narrative Real-Life Example of Problem

For Orifice Plate sites the supplemental agreement states the following permitted uncertainty levels and specified flow ranges:

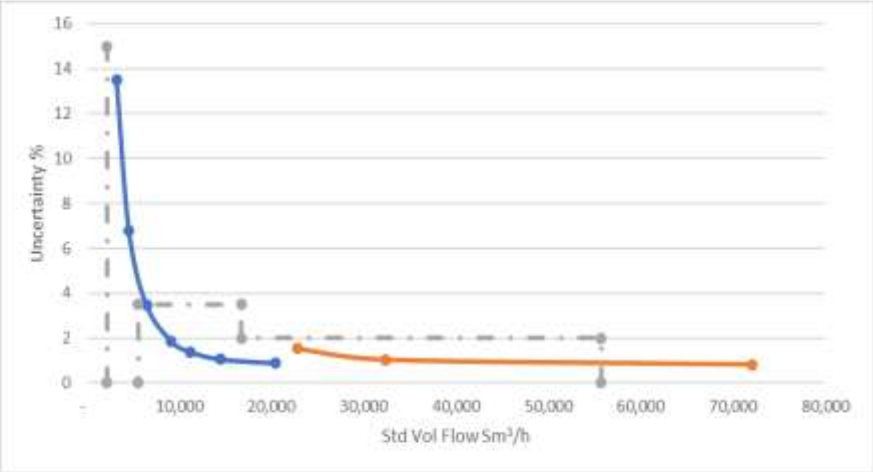
- ±2.0% between 30 and 100% of site capacity
- ±3.5% between 10 and 30% of site capacity
- Should not be operated below 10% except where there is no alternative route to deliver the gas to LDZ.

As Biomethane sites continue to expand over the network, SGN will have issues arising where flows will be under 10% for large periods, extending in duration during low flow months (Summer) which will increase the uncertainty limits exceeding ISO stated standards.

Examples:

Figure 1 below (Armadale Offtake) illustrates that the metering system mostly meets the requirements of the Supplemental Agreement at typical operating conditions except for the region between 10% and 11% of site capacity. Below 10% of the site standard Volume Flow capacity the measurement system uncertainty rapidly increases to 13 %. The duration of the metering system operation in this region is expected to be extended in the summer where a Biomethane site is connected to the downstream network as it slows standard Volume gas flow from the Offtake into the Network.

Figure 1: Armadale Existing Uncertainty



4.2 Spend Boundaries

The following is a breakdown of where the spend will be allocated during GD2 works:

Table 3: Allocation of Spend

Site	Spend	Justification
Armadale	Implementation of both summer and winter orifice plates	Reduced uncertainty and commercial exposure; Payback ~3 months
Careston	Upgrade to 2 x 8" Ultra Sonic Meter	Non-conformance with Supplemental Agreement; Reduced uncertainty and commercial exposure; Payback ~16 years
Kinknockie	Upgrade to 2 x 4" USM	Potential impact of BNEF flows; Non-conformance with Supplemental Agreement; Reduced uncertainty and commercial exposure; Payback ~12 years
Langholm	Upgrade to 2 x 2" 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; Payback 3 to 6 years
Soutra	Upgrade to 2 x 4" USM	Potential under-odorisation; Recovery of unregistered gas
St Fergus	Upgrade to 2 x 3" USM	Non-conformance with Supplemental Agreement

5 Probability of Failure

The likelihood of a serious metering failure is low, and the last recorded major incident occurred back in 2009 at Aberdeen Offtake, which is discussed in detail in section 6. SGN have not recorded any serious failures throughout the network since 2009.

The gas flow range for which the existing Offtake metering system designs were designed to meet has expanded since they were installed. The existing Non USM Offtake metering systems have less ability to deal with this flow range expansion without design upgrade intervention than is the case with newer USM metering systems which have a much-improved turndown capability.

The Renewable Heating Incentive (RHI) scheme has encouraged Biomethane Gas injection into the downstream Network which was not considered in the original meter system designs. This has led to the metering and odorisation system operating more frequently in the increased measurement uncertainty region at the low gas flow end of the metering system range where the metering system accuracy is not optimised.

For the gas odorisation system this means that a default nominal 1% odorant injection dosing rate below 3% of metered gas flow rate is adopted which is not optimised to match gas flow rate from the meter system and may be over or under odorising the gas flowing from the site. This can potentially lead to either over reporting of gas escapes (PRE)s in the case of too much odorant injection, or reduced odorant within the gas making a gas leak harder to detect.

Within the original offtake metering system design there was no allowance made for third party downstream injection of gas. Therefore, there will be extended periods in the summer months where the offtake odorant system injection won't be gas flow rate optimised. This is not expected to cause total failure of the gas odorisation system, but rather highlights a gradual erosion in the system effectiveness of matching exactly Gas flow rate from the meter system to odorant dosing injection rate.

If a non- gas flow matched default odorant injection rate needs to be used for longer periods of time as would be the case where a Biomethane site backs off an offtake below the optimal metering range, this could lead to an increased risk of the odorant within the gas deviating from that required to maintain satisfactory acceptable levels as per the SGN GB safety case.

For more details of measurement uncertainty analysis please see Kelton Engineering (Independent Metering Expert) report (document reference: NK3191V-200)

5.1 Probability of Failure Data Assurance

The data used to generate the Probability of Failure has been collated from routine SGN Annual Maintenance records, T/PR/ME/2 Part 2 Work procedure for validation of equipment associated with measurement systems for the calculation of Mass, Volume & Energy flowrate of gas (within scope) results and Gas Control SCADA system historian. Maintenance faults are recorded on SGN Fault 1 forms for the equipment.

The SGN historian trends flowrate from each offtake site and has been a valuable tool for identifying periods of time where the meter system has been operating below the designed optimised range. This trend information has been used to determine the impact of adding new biomethane injection sites to the downstream network on the existing metering system, where extended periods of un-optimised meter system flow range & (default setpoint) odorisation operation is experienced in the summer months.

Annual metering system validation is undertaken to ensure compliance with the Offtakes Arrangement Document (OAD) of the Unified Network Code (UNC). The ME2 results are cross checked on site and remotely by the dedicated SGN Gas Quality team. A flow rate consolidation check is also undertaken before & after ME2 validation checks by SGN Gas Control. The offtake sites are also subject to planned periodic independent intervention by the OFGEM Gas examiner who will report any anomalies in a formal detailed report.

Independent Metering Experts Kelton Engineering have been engaged to produce a detailed report (Kelton Document Reference: NK3191V-002) for each Offtake site not already upgraded in the GD1 period, where there maybe potential for meter system optimisation required. The report has determined for each offtake site, where the uncertainty of the existing system is no longer fit for purpose and what options are available to restore the metering system uncertainty to acceptable levels. It has also determined sites where an upgrade is unnecessary due to local site flow control usage restrictions which negate any benefit of additional meter system upgrade.

6 Consequence of Failure

Loss of Supply to Customers
Gas supply to customers would not be lost due to a fault or failure on the metering system. Gas will still pass through the network and supply customers as normal. However inaccurate readings can lead to severe ramifications in billing and fiscal revenue for SGN. The odorant injection system optimisation can also be affected.

Safety Impact of Failure
The example below was in relation to the Aberdeen Offtake Significant Measurement Error Record (SMER) which occurred in 2009:

The cause of the Aberdeen Offtake (SMER) was due to the incorrect positioning of the orifice plate within the orifice plate carrier following routine inspection visits.

Following a visit on the 21st July 2009 to inspect and change-out the orifice plate in accordance with annual ME2 metering validation requirements, the orifice plate was not positioned correctly within the orifice plate carrier.

Additionally, during the next annual ME2 orifice plate inspection visit on the 27th July 2010, the orifice plate was again positioned incorrectly within the orifice plate carrier following completion of the procedural inspection activities but this time at a different counter reading than that of 21st July 2009.

Finally, during an emergency intervention visit on the 10th August 2010, the incorrect orifice position was detected and rectified accordingly.

The result of these incorrect orifice plate positions therefore created two separate SMER periods;

- SMER 1: 21st July 2009 to 27th July 2010.
- SMER 2: 27th July 2010 to 10th August 2010.

A SMER report carried out by independent experts Kelton Engineering indicated that an under read of 27.387% was recorded for the SMER 1 period whilst an under read of 70.688% was recorded for SMER 2.

It has been indicated that the Aberdeen meter failed to record 3.2TWh of gas over this time frame which accumulated to millions of pounds.

Additionally, the odorant injection system would have under odourised the gas for the entire period of the Aberdeen SMER as the Gas flow rate sent from the site flow computer to the odorant injection system was also an under read setpoint value based on actual flow measured by the metering system. If this had been a prolonged event there may have been a period where the Gas odour smell used to detect leaks could have diminished below acceptable SGN GB Safety Case limits before rhinology checks would have detected the change. This could have led to an increase in risk that a real gas escape might take longer to detect or go wholly undetected by the public with potential for the gas leak to find an ignition source made more likely.

Environmental Impact
Over odorisation due to inaccurate metering (under read) can lead to an increased risk of Publicly Reported Escapes (PRE)s due to too much stenching agent in the downstream network. This is not expected to lead to major environmental contamination but would increase the OPEX emission/carbon footprint during the subsequent mandatory response to all reported gas escapes. It is expected that the number of call outs to operations would rise dramatically with coincident rise in OPEX costs.

In the case of under odorisation for a prolonged period this could lead to a gas leak being undetected for longer, leading to prolonged release to the environment of methane gas considered to be a contributor to global warming.

7 Options Considered

Replace on Failure
As already stated earlier on in this paper, that the main driver of this works is the uncertainty of measurement and the age of the metering, and not the failure of the metering systems. For this reason, this option has not been considered or included as an option in the CBA.

Repair on Failure
As already stated earlier on in this paper, that the main driver of this works is the uncertainty of measurement of the metering, and not the failure of the metering systems. For this reason, this option has not been considered or included as an option in the CBA.

Pre-emptively replace (Option 1)
This is the ideal strategy for SGN and the most cost-effective route. Firstly, this will allow SGN to plan works and co-ordinate works across the GD2 term. This will also allow SGN to make cost savings with bulk buying and tendering the work as a package, as well as aligning project work with other projects to reduce operational resource and project management hours. Most importantly is that metering uncertainty is kept to a minimum and the uncertainty costs are avoided, and accurate billing is achieved.

Below are the costs associated with pre-emptively upgrading the metering sites:

Table 4: Pre-Emptive Replacement GD2 Costs

LDZ	Sites	Upgrading Costs	Note
Scotland	Armadale	£ 20,000	The cost of an additional seasonal Orifice plate is low for an existing metering system and requires manual intervention which increases OPEX costs. However, this is a low-cost option as it optimises the existing system for lower flows where USM upgrade is not justified.
Scotland	Kinknockie	£700,000	Upgrade to USM
Scotland	St Fergus	£700,000	Upgrade to USM (Volume Driver)
Scotland	Soutra	£700,000	Upgrade to USM

Scotland	Careston	£600,000	Upgrade to USM
Scotland	Langholm	£600,000	Upgrade to USM
South & South East	Mappowder	£200,000	Upgrade to USM
	Total Costs:	**£3,520,000**	
Note: These are NET costs, and Gross costs are included in the CBA.			

Pre-emptively Repair
This option has not been considered as the proposal does not explore the failure or repair of fault assets. Furthermore for metering assets, pre-emptive repair is difficult to achieve as repair works are only required when faults have already occurred. If accurate measurement is still being achieved, pre-emptively repairing kit is unnecessary.

E&I Operations carry out annual ME/2 meter validation checks on the metering system to prove the metering system is functioning correctly. Due to this rigorous procedure pre-emptively repairing metering equipment is not required.

Do Nothing (baseline option in CBA)
This option could prove costly and inefficient for SGN. If SGN do nothing the risk of uncertainty limits being exceeded, and inaccurate billing is high.

Below is a representation if SGN were to do no upgrades on the metering system as part of GD2. The sites are based on those that will be upgraded as part of GD2 works. The 'Do Nothing' scenario has been taken over a period of 20 years which would be the usual lifespan of the metering equipment per site.

Table 5: Avoided costs or Do-Nothing costs

Sites	Uncertainty of Gas flow measurement system Costs / Year *	Lifecycle Years	Total potential cost savings for a 20-year lifecycle if uncertainty of measurement is eliminated from metering system
Armadale	£80,000	20	£1,600,000
Kinknockie	£28,000	20	£560,000
St Fergus	£12,000	20	£240,000
Soutra	£65,000	20	£1,300,000
Careston	£29,000	20	£580,000
Langholm	£3,000	20	£60,000
Mappowder	£310,000	20	£6,200,000
Total Costs:			£10,540,000

*Kelton report (Document Reference: NK3191V-002)

7.1 Metering Upgrade summary details

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

- **Armadale**: Add new seasonal summer Orifice plate to existing meter system.
- **Kinknockie**: Replace Turbine meters with new USM metering system.
- **St Fergus**: Replace Turbine meters with new USM metering system.
- **Soutra**: Replace Orifice plate with new USM metering system.
- **Careston**: Replace Turbine meter with new USM metering system.
- **Langholm**: Replace Turbine meter with new USM metering system.

- **Mappowder**: Replace Orifice plate with New USM metering system.

The basis for the cost estimate/unit cost
- **Armadale**: £20,000
- **Kinknockie**: £700,000
- **St Fergus**: £700,000
- **Soutra**: £700,000
- **Careston**: £600,000
- **Langholm**: £600,000
- **Mappowder**: £200,000

The perceived benefits of the option
- Reduce ongoing OPEX and CAPEX costs.
- Continued compliance with the Unified Network Code.
- Maintain a safe and reliable flow optomised Liquid Gas Treatment odorisation rate.
- Reduce Offtake Metering system uncertainty of measurement.
- Ensure accurate fiscal billing of gas flow from National Transmission system.
- Avoidance of commercial exposure and reputational damage.
- Mitigate effects of Biomethane renewable energy injection onto the downstream network.
- Reduce Significant Metering Error Reports.
- Reduce potential for maintenance error from changing orifice plates.
- Improved metering system turndown for new USM sites.

Delivery timescales
Within first 5 years of GD2 2021/2025

Key assumptions made
- Project will be delivered and phased within timescale.
- Project will be based on costs prior to Brexit taking place.
- ATEX/EC type approved E&I equipment will be available to purchase post Brexit without significant additional tariffs.
- BSEN/ISO metering standards remain largely unchanged post Brexit.
- No significant changes to the Unified Network Code.
- Metering system uncertainty requirements remain unchanged in GD2 period.
- OFGEM FWACV requirements remain the same for GD2 period.

Any other items that differentiate the option from the others considered
- For USM upgrades this will minimise physical disturbance of the meter system once setup. This should minimise human errors due to unintentional incorrect reassembly.
- Improved metering system uncertainty of measurement for most sites where expenditure is justified.
- More potential for adding Renewable Biomethane gas injection to downstream network than other options.
- Reliability and sustainability of fiscal metering system secured for GD2 period.
- Optomises LGT injection at low flow rates where USM meters are used.
- No upgrades required where sites have been assessed independently as being under control due to flow rate restrictions in place at lower flows and/or local network provides redundant supply routes.

7.2 Do Nothing

The technical detail of the option i.e. capacity, system rating, availability etc.
No viable alternative options

The basis for the cost estimate/unit cost
£0

See table 6 for potential loses in revenue due to upgrades or replacement works at SGN metering sites not being completed over the GD2 term. The figures specified are from table 5 and have been split up between the Scottish and Southern networks.

Over a period of time metering systems can begin to 'drift' which increases metering uncertainty. This will lead to inaccurate flow measurement and a loss in revenue due to billing not being precise.

The perceived benefits of the option
N/A

Delivery timescales
N/A

Key assumptions made
N/A

Any other items that differentiate the option from the others considered
N/A

7.3 Options Technical Summary Table

Table 6: Options Technical Summary

Option	First Year of Spend	Final Year of Spend	Volume of Interventions	Equipment / Investment Design Life	Total Cost
Scotland LDZ					
Do Nothing	2022	2026	0	45	1.09
pre-emptive replacement	2022	2026	6	45	4.15
South of England LDZ's					
Do Nothing	2022	2026	0	45	1.55
pre-emptive replacement	2022	2026	1	45	0.25

7.4 Options Cost Summary Table

Table 7: Cost Summary

Option	Cost Breakdown	Total Cost (£m)
	Scotland LDZ	
Do nothing	Opex costs – see Appendix A for cost breakdown	1.09
Pre-emptive Replacement	Please see Appendix A for cost breakdown.	4.15
	South of England LDZ's	
Do nothing	Opex costs – see Appendix A for cost breakdown	1.55
Pre-emptive Replacement	Please see Appendix A for cost breakdown.	0.25

8 Business Case Outline and Discussion

8.1 Key Business Case Drivers Description

Armadale: Summer Orifice Plate Install

The capital cost of a new calibrated orifice plate is £1,000, operationally a technician and mechanical team would need to swap the orifice plates twice a year (as opposed to currently only once per year), the demand forecasts would need to be carefully monitored to ensure that the summer plate is installed late enough and removed early enough to avoid higher flows and there would be an increase in vented gas.

In the sample data if the summer plate were installed on 1st May and removed on 1st October the flow-weighted uncertainty over the 2017/18 period would been approximately ±1.6% (±1.04 MSm3 or ±£164,000). This is a reduction in exposure of ±0.5 Mscm or ±£80,000 per annum. Additionally, during the summer period the low DP cut-off would equate to a lower flow of 450 Sm3/h (less than 1% of site capacity), providing more accurate odorant injection and improved operational visibility.

Kinknockie: 4" USM install

Installation of twin 4" ultrasonic meter streams in place of the turbine meter streams would be a significant modification to the site and the site would be required to meet ±1.0% permitted uncertainty over the entire flow range. Therefore, both streams would need to be upgraded to meet this requirement. Installation of two new metering streams is generally expected to cost between £340,000 and £600,000. The standby stream could be upgraded while the duty stream remained operational avoiding the need to shut down the site or bypass the metering.

Due to the greater turndown ratio the benefits of installing an ultrasonic meter would be more accurate odorant injection, improved operational visibility and a reduction in exposure. The metering uncertainty would be improved compared to the other options. As the site would be required to meet ±1.0% uncertainty, over the 2017/18 period this be a reduction in exposure of between ±0.05 Mscm and ±0.17 Mscm per annum or between ±£7,500 and ±£28,000 per annum.

Mappowder: 8” USM install
Installation of a twin 8” ultrasonic meter streams in place of the orifice meter stream would be a significant modification to the site and the site would be required to meet ±1.0% permitted uncertainty over the entire flow range. Installation of a new metering stream is generally expected to cost between £315,000 and £600,000.

Due to the greater turndown ratio the benefits of installing an ultrasonic meter would be more accurate odorant injection, improved operational visibility and a reduction in exposure. The metering uncertainty would be improved. The site would be required to meet ±1.0% uncertainty, over the 2017/18 period this be a reduction in exposure of between ±0.53 Mscm and ±1.96 Mscm per annum or between ±£84,000 and ±£310,000 per annum. Careston: 8” USM install

Soutra: 4” USM install
Installation of a twin 4” ultrasonic meter streams in place of the orifice plate meter stream would be a significant modification to the site and the site would be required to meet ±1.0% permitted uncertainty over the entire flow range. Installation of a new metering stream is generally expected to cost between £305,000 and £600,000. There may be operational constraints as it is likely that the site would need to be shut down, or a temporary bypass would need to be installed, to install the new metering. This would not introduce any redundancy.

Due to the greater turndown ratio the benefits of installing an ultrasonic meter would be more accurate odorant injection, improved operational visibility and a reduction in exposure. The metering uncertainty would be improved. The site would be required to meet ±1.0% uncertainty over the 2017/18 period this be a reduction in exposure of between ±0.16 Mscm and ±0.41 Mscm per annum or between ±£26,000 and ±£65,000 per annum.

Careston: 8” USM install
Installation of a twin 8” ultrasonic meter streams in place of the single 12” turbine meter stream would be a significant modification to the site and the site would be required to meet ±1.0% permitted uncertainty over the entire flow range. Therefore, the streams would need to be upgraded to meet this requirement. Installation of two new metering streams is generally expected to cost between £325,000 and £600,000.

Due to the greater turndown ratio the benefits of installing an ultrasonic meter would be more accurate odorant injection, improved operational visibility and a reduction in exposure. The metering uncertainty would be improved compared to the other options. The existing uncertainty is reasonable and the potential reduction in exposure, of up to ±0.18 Mscm or ±£29,000 per annum, would result in a payback of around 16 years. This is a long payback period but is necessary as the current metering is not fit for purpose as it may be operating out with its calibrated range E.G. below 10% cut off for prolonged periods due to Biomethane site injection and not meeting the requirements of the Supplemental agreement.

St Fergus: 3” USM install
Installation of a twin 3” ultrasonic meter streams in place of the turbine meter stream would be a significant modification to the site and the site would be required to meet ±1.0% permitted uncertainty over the entire flow range. Therefore, both streams would need to be upgraded to meet this requirement. Installation of two new metering streams is generally expected to cost between £325,000 and £600,000. The standby stream could be upgraded while the duty stream remained operational avoiding the need to shut down the site or bypass the metering.

Due to the greater turndown ratio the benefits of installing an ultrasonic meter would be more accurate odorant injection, improved operational visibility and a reduction in exposure. The metering uncertainty would be improved compared to the other options. As the site would be required to meet ±1.0% uncertainty, over the 2017/18 period this be a reduction in exposure of between ±0.01 Mscm and ±0.08 Mscm per annum or between ±£2,100 and ±£12,000 per annum.

Langholm: 2" USM install

Installation of a twin 2" ultrasonic meter streams in place of the single 2" turbine meter stream would be a significant modification to the site and the site would be required to meet ±1.0% permitted uncertainty over the entire flow range. Therefore, the streams would need to be upgraded and moved to after pressure reduction to meet this requirement. Installation of two new metering streams is generally expected to cost between £325,000 and £600,000.

Due to the greater turndown ratio the benefits of installing an ultrasonic meter would be more accurate odorant injection, improved operational visibility and a reduction in exposure. The metering uncertainty would be improved compared to the other options. As the site would be required to meet ±1.0% uncertainty, over the 2017/18 period this be a reduction in exposure of more than ±0.015 Mscm or ±£3,000 per annum. This is a long payback period but is necessary as the current metering is not fit for purpose as it is operating on the HP side of the site out with its calibrated range and not meeting the requirements of the Supplemental Agreement.

Table 8: Summary of Key Value Drivers

Option No.	Desc. of Option	Key Value Driver
Armadale	Install Summer Orifice plate	Reduction of measurement system uncertainty
Kinknockie	Install twin USM meters	Reduction of measurement system uncertainty
St Fergus	Install twin USM meters	Reduction of measurement system uncertainty
Soutra	Install twin USM meters	Reduction of measurement system uncertainty
Careston	Install twin USM meters	Reduction of measurement system uncertainty
Langholm	Install twin USM meters	Reduction of measurement system uncertainty
Mappowder	Install twin USM meters	Reduction of measurement system uncertainty

Table 9: Summary of CBA Results

NPVs based on Payback Periods (absolute, £m)								
Option No.	Desc. of Option	Preferred Option (Y/N)	Total Forecast Expenditure (£m)	Total NPV	2030	2035	2040	2050
Scotland LDZ								
Baseline	Do Nothing	N	-1.09	-5.04	-1.15	-1.80	-2.42	-3.49
1	Pre-emptive replacement Absolute NPV	Y	-4.15	-3.88	-2.80	-3.18	-3.45	-3.74
1	Pre-emptive replacement relative to Baseline	Y	-4.15	-3.88	-1.65	-1.38	-1.03	-0.25
South of England LDZ's								
Baseline	Do Nothing	N	-1.55	-7.27	-1.78	-2.73	-3.62	-5.13
1	Pre-emptive replacement Absolute NPV	Y	-0.25	-0.24	-0.18	-0.20	-0.21	-0.23
1	Pre-emptive replacement relative to Baseline	Y	-0.25	-0.24	1.60	2.53	3.40	4.90

8.2 Business Case Summary

Table 10: Summary of options

	Options	Contributory factors
1	Pre-emptive replacement	• Scheduled replacement over a period • Reduced operational cost • Avoidance of metering uncertainty costs • Cost savings associated with packaged/tendered works
2	Do nothing	• Inaccurate billing • Excessive costs associated with metering uncertainty • LGT Low flow cut off issues – potential to under or over odorise gas in the network. • Non-Compliance with Supplementary Agreement • Biomethane injection will erode duration of system compliance

Table 11: Business Case Matrix

	Pre-emptively Replace	Pre-emptively Replace
	Scotland	South of England
GD2 Capex (£m)	4.15	0.25
Number of Interventions	2.00	1.00
Carbon Savings ktCO2e (GD2)	0.00	0.00
Carbon Savings ktCO2e /yr	0.00	0.00
Carbon Emission Savings (35yr PV, £m)	0.00	0.00
Other Environmental Savings (35yr PV, £m)	0.00	0.00
Safety Benefits (35yr PV, £m)	0.00	0.00
Other Benefits (35yr PV, £m)	0.00	0.00
Direct Costs (35yr PV, £m)	0.20	5.63
NPV (35yr PV, £m)	0.20	5.63
High Carbon Scenario		
Carbon Emission Savings (35yr PV, £m)	0.00	0.00
High Carbon NPV (35yr PV, £m)	0.20	5.63

9 Preferred Option Scope and Project Plan

9.1 Preferred option

The Metering upgrade programme of the identified Offtake sites will allow SGN to continuously supply gas to the network with little to no disruption. Upgrading to USMs and the installation of summer and winter orifice plates, allows for reduced uncertainty and increased accuracy of attaining flow measurement for billing purposes.

9.2 Asset Health Spend Profile

Table 12: Spend Profile

Asset Health Spend Profile (£m)					
Pre-emptively replace	2021/22	2022/23	2023/24	2024/25	2025/26
Scotland LDZ	0.83	0.79	0.78	0.85	0.91
South of England LDZ	0.05	0.05	0.05	0.05	0.05

9.3 Investment Risk Discussion

Armadale
Installation of a summer orifice plate to the site will bring the meter system uncertainty to an acceptable level at minimum cost. The plate changeover from Summer / Winter flow rates will need to match seasonal demand and be controlled accordingly to avoid the higher flow rates. This option has an ongoing OPEX cost for changing plates but delivers a cost-effective option with potential payback in the first 3 months. This option does not reduce the risk from Human error in fitment of the Orifice plates and involves more disturbance of the metering system.

Careston
Installation of twin USM meter streams to the site will bring the meter system uncertainty to an acceptable level and provide a reduction in exposure. The improved turndown provided by the new USM meters will improve uncertainty of measurement at lower flow rates and optomise gas treatment odorisation. This option also reduces ongoing Opex costs associated with meter system maintenance. Without upgrade if maximum Biomethane site injection flows were to be factored in the site would be operating below the 10% meter cut off point for 45% of the time, this would be a significant non-compliance with the supplemental agreement.

Kinknockie
Installation of twin USM meter streams to the site will bring the meter system uncertainty to an acceptable level. The improved turndown provided by the new meters will improve uncertainty of measurement at lower flow rates and optimise gas treatment odorisation. This reduces also reduces ongoing Opex costs associated with Meter system maintenance. Without upgrade if maximum Biomethane site injection flows were to be factored in the site would be operating below the 10% meter cut off point for 43% of the time, this would be a significant non-compliance with the supplemental agreement.

Langholm
Installation of twin USM meter streams to the site will bring the meter system uncertainty to an acceptable level. The improved turndown provided by the new meters will improve uncertainty of measurement at lower flow rates and optimise gas treatment odorisation. This also reduces ongoing Opex costs associated with meter system maintenance. This will also reduce the risk from Human error as it involves less disturbance of the metering system. The current HP located meter system is operating outside of its calibration range for most of the time. The new USM system would locate meters post pressure reduction on site to bring the meter system flow within the calibrated range of the meters to ensure full compliance with the supplemental agreement.

Mappowder
Installation of twin USM meter streams to the site will bring the meter system uncertainty to an acceptable level. The improved turndown provided by the new meters will improve uncertainty of measurement at lower flow rates and optimise gas treatment odorisation. This reduces ongoing Opex costs. This will also reduce the risk from Human error as it involves less disturbance of the metering system. The main driver for this upgrade is reduction of commercial exposure.

Soutra
Installation of twin USM meter streams to the site will bring the meter system uncertainty to an acceptable level. The improved turndown provided by the new meters will improve uncertainty of measurement at lower flow rates and optimise gas treatment odorisation. This reduces ongoing Opex costs. This will also reduce the risk from Human error as it involves less disturbance of the metering system. The main driver is significant reduction in commercial exposure.

St Fergus
Installation of twin USM meter streams to the site will bring the meter system uncertainty to an acceptable level. The improved turndown provided by the new meters will improve uncertainty of measurement at lower flow rates and optimise gas treatment odorisation. This reduces ongoing Opex costs. This will also reduce the risk from Human error as it involves less disturbance of the metering system. The existing site meter system is operating significantly (51%) outside of its specified range and below its calibrated range for 23% of the time. This is a significant non-compliance with the supplemental agreement. A hydrogen innovation project may also affect this site in the future, so this will need to be considered.

Risk Matrix

Risk Description	Impact	Likelihood	Mitigation/Controls
Under/Odourisation of gas	Safety - under odorised gas in the network or over odourisation resulting in greater callouts for false leaks.	>20% & <=40%	Carry out metering uncertainty project work
Budget	Over Spend	<=20%	It is imperative that these works are tendered and design are standardised so achieve maximum efficiency
Delivery	Delay	<=20%	SGN must ensure the in house resource is available - to commission the metering systems. This was an issue in GD1

CAPEX Sensitivity

Table 13: Sensitivity Results

	Scotland LDZ			South of England LDZ's		
	Low	Mid	High	Low	Mid	High
GD2 Capex (£m)	3.53	4.15	4.78	0.21	0.25	0.29
Number of Interventions	2	2	2	1	1	1
Carbon Savings ktCO2e (GD2)	-	-	-	-	-	-
Carbon Savings ktCO2e /yr	0	0	0	0	0	0
Carbon Emission Savings (35yr PV, £m)	0.0	0.0	0.0	0.0	0.0	0.0
Other Environmental Savings (35yr PV, £m)	0	0	0	0	0	0
Safety Benefits (35yr PV, £m)	0.0	0.0	0.0	0.0	0.0	0.0
Other Benefits (35yr PV, £m)	0.0	0.0	0.0	0.0	0.0	0.0
Direct Costs (35yr PV, £m)	0.8	0.2	-0.4	5.7	5.6	5.6
NPV (35yr PV, £m)	0.8	0.2	-0.4	5.7	5.6	5.6

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

Network E&I believe the preferred option is pre-emptive replacement. For the purpose of sensitivity analysis, the following has been applied to the preferred option of pre-emptive replacement:

Low Case: SGN have applied a reduction of 15% CAPEX costs – this can be applied if SGN achieve greater than expected discounts on material purchase and also if greater efficiencies can be achieved in projects delivery that haven't already been fed into the costs – this would be process improvements and streamlining working practices to reduce mobilisation time on site. CAPEX costs can be further decreased if there is minimal mechanical/civils work associated with the metering replacement.

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

High Case: SGN have applied an additional 15% on the CAPEX expenditure, as this is believed to be the potential cost increase if SGN do not go to tender and achieve best possible market prices. This could also be impacted by political changes which may impact on resource availability or material costs. This increase in cost also allows for any issues in obtaining generic designs for the full volume of works or SGN not being able to delivery these projects efficiently due to internal processes which would increase contract labour costs. These costs could also rise if there are ad-hoc meter upgrades required due to demand changes, however SGN see this as unlikely as demand forecasting has already been built into SGN business plan.

Capitalisation Sensitivity

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

The scenarios are summarised as follows:

- Scenario 1 - we have used the blended average of 65%, used in previous iterations of this analysis.
- Scenario 2 - we have represented the Capex and Opex blend for the two networks, as per guidance.
- Scenario 3 - addresses our concerns on capitalisation rates whereby Repex and Capex spend is deferred (100% capitalisation rate) and Opex is paid for upfront (0% capitalisation rate).
- Scenario 4 - this reflects the payback period in 'project' / cash-flow terms and provides a project payback.

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

Table 14: Capitalisation Rate Sensitivity Results - Scotland

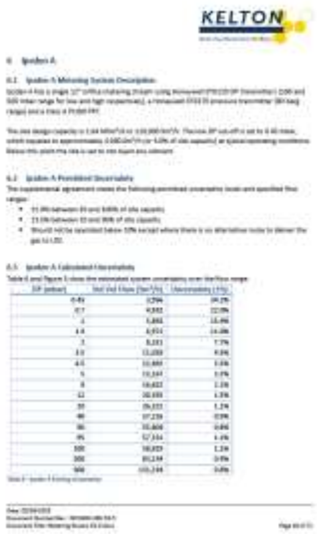
Scenario	1	2 SC	3	4
Capex (%)	65	46	100	0
Opex (%)	65	46	0	0
Repex (%)	100	100	100	0
Output				
NPV (20yr PV, £m)	-1.07	-0.95	0.15	
NPV (35yr PV, £m)	0.03	0.20	0.73	
NPV (45yr PV, £m)	0.74	0.87	1.21	
Payback	34.00	32.00	0.00	26.00

Table 15: Capitalisation Rate Sensitivity Results – South of England

Scenario	1	2 SO	3	4
Capex (%)	65	38	100	0
Opex (%)	65	38	0	0
Repex (%)	100	100	100	0
Output				
NPV (20yr PV, £m)	3.03	3.57	4.37	
NPV (35yr PV, £m)	5.24	5.63	6.19	
NPV (45yr PV, £m)	6.35	6.63	7.02	
Payback	0.00	0.00	0.00	0.00

Appendix A - Appendix-Cost

Costs for these works have been derived from Kelton (Document Reference: NK3191V-002)


KELTON

Appendix B - Acronyms

Acronym	Description
SGN	Scotia Gas Networks
DNO	Distribution Network Operator
NTS	National Transmission System
BNEF	Biomethane Network Entry Facility
LDZ	Local Distribution Zone
PRE’s	Public Reported Escapes
USM	Ultra-Sonic Meter
SMER	Significant Metering Error Report