Concept Design Report

Biomethane Blending and Propane Mitigation

BLD/GEN/RPT/0001/2.0

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Contents

1 Introduction

This report has been compiled to detail the aim, scope, concept development and resultant concept designs for "blending solutions" at a selection of existing biomethane gas to grid installations on the SGN networks.

1.1 Project Aims

This project is designed to deliver the Scotland and Southern Gas Network's Gas Transporter Licence Special Condition 3.30 'Biomethane improved access rollout Price Control Deliverable (PCD)'. The project looks to implement rollout technologies or 'interventions' to maximise biomethane gas injection flow rates by utilising blending methods to reduce the volumes of propane currently required to be blended with biomethane to eliminate the potential for calorific value (CV) capping to occur.

1.2 Project Brief

The brief for the project is to develop a concept design that, once ratified, can be applied to the sites in question. The concept design should include the following requirements:

- Consider the base data, including network 'Blending Studies' compiled for the selected sites to enable this concept design development process.
- Identify the concept for the most appropriate engineering solution, including appropriate control philosophy to increase the amount of biomethane entering SGN's network by reducing the volumes of propane required at the nominated (existing) SGN biomethane connection points.
- Apply this concept to each of the agreed sites.
- An approximate budgetary cost for implementing the solution.
- An approximate calculation of the expected reduction in propane usage utilising the conceptual design.
- The conceptual design must eliminate any risk of CV Capping on the SGN gas network.
- An indicative timescale for implementation.

The Concept Design will be used to help SGN make a decision on which Projects can proceed to detail design and implementation.

1.3 Glossary of Technical Terms

The terms used through this document are detailed below:

Term	Abbreviation	Description
Seasonal Normal Temperature	SNT	Seasonal Normal Temperature demand case.
Calorific Value	CV	Calorific value.
Network Target CV	Network Target CV	Gas Control prescribed target for network CV.
National Transmission System	NTS	The UK's national backbone for gas transmission.
Flow Weighted Average CV	FWACV	The FWACV is used directly in customer billing.
Control of Thermal Energy Regulations	COTER	Control of Thermal Energy Regulations.
Connection Point	Connection Point	The point at which biomethane is injected into the gas network.
Grid Entry Unit	GEU	The monitoring and control system on the DFO site.
Delivery Facility Operator	DFO	The operator of the AD/Gas to Grid site.
Remote Telemetry Unit	RTU	Local control/telemetry facility.
Remote Monitoring Point	RMP	The new instruments and equipment proposed at the Blended Point.
CV Determination Device	CV DD	An instrument used to officially evidence CV (etc).
Gas Safety Management Regs	GSMR	Gas Safety Management Regulations
Blended Point/Co-mingled point	Blended Point	The point at which, downstream of the Connection Point, biomethane and natural gas are considered fully comingled.
Comingled CV	Comingled CV	The CV of the comingled biomethane and natural gas (as measured by the CV DD).
Network Flow rate	Network Flow	The actual flow in the network immediately upstream of the biomethane connection.
Network CV	Network CV	The actual CV of the gas in the network immediately upstream of the biomethane connection.
Biomethane Flow Rate	Biomethane Flow	Actual export flow of biomethane.
Biomethane CV	Biomethane CV	Actual CV of export biomethane.
Biomethane Target CV	Biomethane Target CV	The target that the NEF is controlling the Biomethane CV to.
Combined Flow	Combined Flow	The sum of Network Flow and Biomethane Flow.
Network Target CV	Network Target CV	Target CV sent by SGN's Gas Control and is the CV of the comingled gas must be controlled to

Offset	Offset	The amount by which the Network Target CV is reduced to (in appropriate circumstances) to adjust the Biomethane Target CV.

2 Base Data & Blending Studies

As noted above, SGN provided the study team with data pertaining to each of the proposed sites. As well as information about the physical location and nature of the G2G installations and their network connections, the findings of a Blending Study was included in each case.

2.1 Blending Study Approach

The blending study utilises a spreadsheet-based model to simulate the demand at the biomethane injection point, from the demand it then calculates the required propane level to achieve the Network Target CV. The historic (actual) Network Target CV data was obtained for a year along with network demand data which was used to calculate natural gas flow rate in the injection main.

The study was run at 3 different demand scenarios, these being Cold, Seasonal Normal (SNT) and Warm and then SNT scenario was selected as the base line. The projected saving would need to be reassessed for the other demand scenarios. Also, it should be noted that the demand figures used were based on temperature lead demand with cut down industrial loads matching the profile of the temperature sensitive loads .

The study developed 3 different operating modes:

- BE – A mixture of blending (where no propane is added) and enrichment (where some propane is added).
- B – Pure blending only (without any propane enrichment).
- E – Enrichment with propane. (Within this mode, a subgroup E:CV was defined. E:CV indicates the time that the Network CV was lower than the Network Target CV due to the dynamics of the network in question and the delay between changes in NTS Offtake gas (used to derive the Network Target CV) and that gas appearing in the lower tier network).

The blending study approach was to calculate total energy required downstream of the biomethane injection point and then calculate the required energy increase required in the biomethane, energy increase being calculated out as Kg of propane. The biomethane flow rate was assumed to be constant at an average high level of 80% of the agreed injection capacity. To complete the estimated reduction in required propane the base level of propane required was calculated. This again was assumed at the same average biomethane flow rate, with the energy increase required to raise the biomethane from a typical value of 37.0 Mj/m3 to the average Network Target CV value.

In the table below the findings of the blending studies have been grouped together and indicate the expected time that each of the modes of operation could be expected to operate in. As can be seen in the farm results, the time that Mode B (pure blending) was predicted was quite low, with the maximum figure being 25%, this added to the Mode E, full enrichment figure of 15% gives rise to the Mode BE (modulating the propane injection amount to meet the Network Target CV at the blend point) of 59.5%.

The estimated savings in the Blending studies is based on theoretical values and no allowance has been applied for system operational performance or tolerance. For example, it is assumed that propane can be switched off completely for the pure blending mode (Mode B) but the reality is that this mode would almost certainly be required for short periods and the transition to Mode BE, some level of propane injection would lead to system trips during the mode change over. This study noted these simplifications and the concept solution presented herein is configured to address them and/or identify them for further investigation as and when the solution is implemented.

2.2 Blending Study Findings

The table below details the Blending Study findings as % of time spent in each mode and potential % reduction of propane in each case. These results were presented by the blending study for the SNT with reduced industrial loads.

Site	B	BE	E	Propane Annual Tonnes (No Blending)	Propane Annual Tonnes (Blending)	Propane Saving %
Site A	10.7 %	72.0 %	17.3 %	401	253	36.9%
Site B	25.3 %	59.5%	15.0%	998	419	42.0%
Site C	0.0 %	37.0 %	61.6 %	265	250	5.8 %
Site D	17.6 %	66.1 %	16.3 %	458	289	36.9 %
Site E	1.5 %	62.0 %	35.8 %	744	578	22.3%
Site F	2.3 %	49.9 %	46.4 %	189	160	15.5 %
Site G	60.4%	37.8%	1.8%	362	78	78.4%
Site H	47.9%	45.9%	6.1%	322	110	66.0%

As required in the scope, having developed a deployable and satisfactory concept, this study will review and quantify the potential savings based on the features of the concept solution proposed.

3 Solution Concept

In this Section, the drivers, prerequisites, and constraints for blending are explored. A concept solution is then presented, and a proposed system configuration is described.

3.1 Prerequisites, Constraints & Existing Examples

These aspects are considered herein.

What is Blending and Why is it Required?

Blending is the desire to mix two different gasses together to make a uniform gas, the mixing regime needs to account for the varying flows of each gas along with their individual compositions. The current position is that a biomethane site transports the biomethane into the gas network at a Calorific Value (CV) determined by the gas network. As the typical CV of biomethane is 37.0 Mj/m3, which is lower than CV determined by the gas network, the standard practice includes the addition of a suitably rich gas to elevate the CV of the biomethane to match the required target value. Propane, with a typical CV of 95.76 Mj/m3 is the preferred gas used to achieve this. Therefore, each biomethane site blends produced biomethane with propane to elevate the CV to the required target.

(Bio Flow sm3/hr x Biomethane CV (37 Mj/m3) + Propane Flow sm3/hr x Propane CV (95.76 Mj/m3)) =

Comingled Cv Mj/m3 (Biomethane Flow (sm3/hr) + Propane Flow (sm3/hr))

From the expression above, it is clear that the CV of the resultant blended gas is dependent on the CV and flow ratio of the two gasses.

Regulatory Constraints

As per Part 4A of 1997 Amended Regs Gas Calculation of Thermal Energy Regulations (COTER), capping occurs when the CV of the network gas is more than 1MJ below the LDZ Flow Weighted Average Calorific Value (FWACV). The FWACV is used directly in customer billing and ensures that individual users are not disadvantaged by variations in the energy content of gas they receive. (There is currently a current mechanism in COTER allows a customer to receive gas up to 1MJ below the wider LDZ FWACV and in turn they can pay for gas at 1MJ higher than the actual gas they receive). SGN prevents a capping incident, where the average CV from a biomethane site is less than 1 Mj/m3 below the FWACV, by declaring a Target Calorific Value. The Target CV is estimated before the start of gas day (05:00) and updated throughout the day if required. For a blending solution, the control philosophy principal must ensure that the gas energy at the blending point (as measured by a directed instrument) will meet the target for the CV for the day (and absolutely must not fall below 1 MJ/m3 below the FWACV for the Network). SGN set the Network target CV for their networks to be 0.6 MJ/m3 below the forecast LDZ FWACV. Any blending solution control will need to operate to maintain the Comingled CV at the SGN Network Target CV value. In order to maximise propane savings (once the system performance has been verified), there is potentially scope to take up some of the 0.4 MJ/m3 headroom by letting the Comingled CV ‘droop’ below the target for short periods.

For a blending solution where the two gasses are intentionally mixed within the network pipe infrastructure, no customer should take gas from the pipe system between the injection point and the blended comingled point.

Any biomethane supplied for blending must be controlled to ensure compliance with Gas Safety Management Regs (GSMR). As this is already being done in the GEU at any existing biomethane site, there should be no need for additional GSMR initiated monitoring or control.

Tried and Tested Solutions

Within SGN's Southern area, a trailer download facility exists that facilitates the download of "biomethane (~37.0 Mj/m3) into the local gas transmission system by employing the process of blending based on the ratio of the flow rate of biomethane and network gas. This system traditionally works on a blending ratio of at least 4:1. (4 parts network gas to 1-part biomethane gas). At this facility, the biomethane flow rate from the tanker is reduced to maintain the blending ratio and maintain the Target CV at the Blended Point. In the case of biomethane gas to grid sites, that arrangement is clearly not always possible as the AD operator will want to maintain/maximise production.

3.2 Solution Concept

The solution concept being proposed is described below.

Basic Concept

As stated previously, using the ratio of the flow of biomethane against the flow of network gas is considered the way forward. However, this concept proposes to apply a variable offset to the existing Network Target CV. The value of offset is based on the flow ratio between the Biomethane Flow/Biomethane CV and Network flow/ Network CV with the aim of achieving the Network Target CV at the Blended point. To achieve this solution primary data required would be:

- Biomethane Flow rate.
- Biomethane Calorific Value.
- Network Flow rate.
- Network Calorific Value.
- Network Target Calorific Value.
- Comingled Calorific Value.

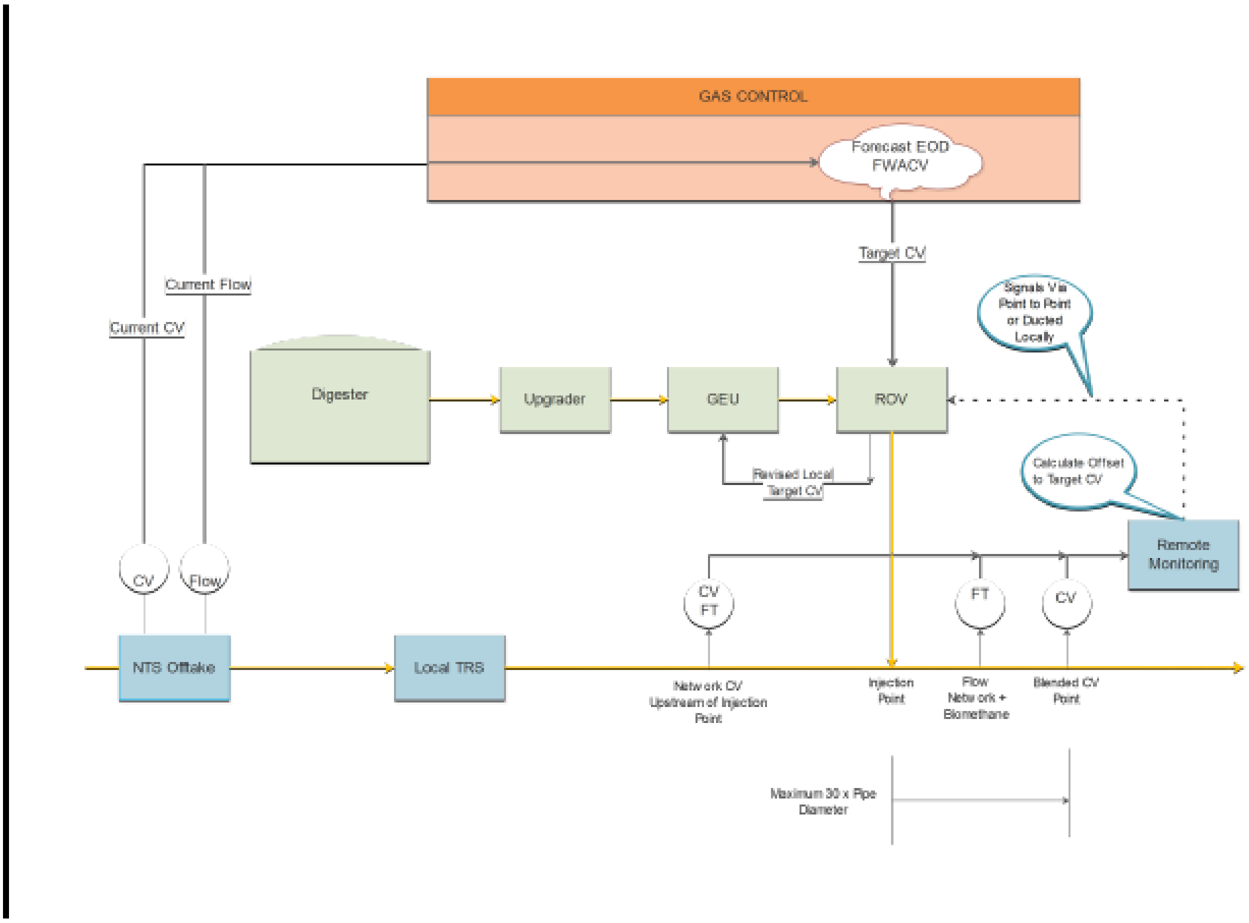
Current systems installed already provide Biomethane Flow rate and Biomethane CV and the sites already receive a Network Target CV from Gas Control.

The "retro-fit "solution being proposed here involves the following:

- Install Network CV measurement device 'upstream' of the Connection Point to determine the Network CV value.
- Install Network Flow measurement device 'upstream' of the Connection Point to determine the Network Flow value.
- Mix the produced biomethane in the gas main (via the existing/standard 'tee' connection) and allow the two gasses to comingle naturally.

- Install a flow measurement device downstream of the Connection Point and upstream of the Blended Point.
- Install an Ofgem approved CV Determination Device at the Blended Point, as required by Control of Thermal Energy Regulations (COTER) regulations.
- Calculate and apply a CV Offset to the Network Target CV sent to the existing biomethane site by Gas Control. The value of this offset will be determined by an automated algorithm which calculates the optimum offset to be applied by analysing current site data. The CV Offset values will range between 0 (no offset) and a site-specific maximum value chosen to maintain steady propane addition at a minimal propane flow rate.
- The CV Offset will always be calculated based on Network Flow, Network CV, Biomethane Flow and Biomethane CV. The Comingled CV being monitored by the CV DD will not be used in control. However, to achieve a high level of fault tolerance, the Comingled CV value from the official CV DD instrument will be used to provide an independent trip which will return the CV offset to zero and return the Biomethane Target CV in the NEF to match the Network Target CV (hence reinstating propane addition at prior rates).
- A second trip will also set the CV Offset to zero for the small number of occasions where the Network CV is lower than the Network Target CV sent from gas Control. (The upstream Network CV measurement being used for this function). With the CV Offset set to zero, the biomethane will again be fully enriched to achieve the Network Target CV at the biomethane site outlet as per a site without blending.
- If the CV DD at the remote monitoring point develops a fault and raises a ‘System 1’ alarm, then the CV Offset will also be set to zero therefore returning the site to full enrichment (again as per a site without blending).
- A trip will set the CV Offset to zero where the Network flow rate is less than a threshold value, this ensures that the site is at full Network Target CV before any reverse flow condition can occur.
- A trip will set the CV Offset to zero where the biomethane flow rate is less than a site-specific appropriate threshold value. This ensures that the biomethane site will always start to flow with the blending CV Offset set to zero.

A schematic representation of this arrangement is included below:



Blending System Schematic.

It is important to note that proposed system varies the amount of propane being added (down to practically acceptable limits) but never switches propane off entirely. The main reason for this is to reduce the risk that the site would need to respond to a zero CV Offset condition because of a protection trip and the site propane system not being ready or able to respond in time creating a diversion event (which would divert biomethane to flare). The propane control system on existing sites, which were designed for 'normal' propane dosing levels, have practical limits in terms of turn-down. Following engagement with popular propane system OEMs, it is confirmed that most systems will likely be suitable with limited or no modifications. (Modification to the injection nozzle sizing on liquid injection systems or the selection of a better suited flow control orifice for gas propane systems may need to be investigated on a site-by-site basis).

At sites where the ratio of Network flow to Biomethane Flow is expected to be more than 4:1 for extended periods, and where the existing propane system is suitable (or could easily be modified), it may be worth considering an enhancement to the control concept so that propane dosing is completely ceased when conditions allow. This would need to be assessed at the implementation phase, and the overarching (ratio-based control/offsetting) philosophy would still need to be observed.

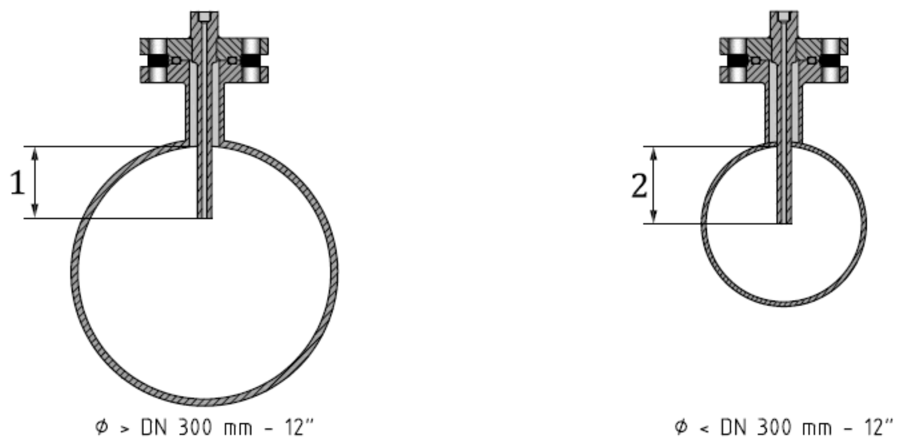
Network Flow and CV

For blending to be based on the principal of Network Flow to Biomethane Flow ratio, then it follows that it will be necessary to measure and evaluate both the Network Flow rate and Network CV of the gas presented to the Connection Point. By utilising the actual Network Flow, the system will automatically account for situations where the Network demand is low and pre-empts a flow reversal situation by requesting a zero CV Offset to Biomethane Target CV (with full propane addition). Using the Network CV value of the network gas to stop blending and return to full propane addition (as now) for the few situations expected each year where due to low demand and time of flight delays in the network that result in a higher Network Target CV than the actual Network CV value measured in the local network.

Mixing / Blending

According to BS EN ISO 10715:2022, where a gas is to be sampled, the sample location chosen should be at least five pipe diameters downstream of any obstruction in the pipe, orifice plate, elbow, valve, thermowell etc. It should be installed in an active part of the gas stream and located ideally in the vertical plane, although it is acceptable to be mounted at up to forty-five degrees with the probe pointing downwards.

To avoid the wall effects and ensure a representative sample; whilst considering mechanical resistance, standard industry practice is to locate the sample probe within the centre one third. For pipes larger than DN300mm (12”) it is necessary to insert beyond a minimum 100mm from the pipe wall, but it is not necessary to insert beyond 10% to achieve a representative sample.

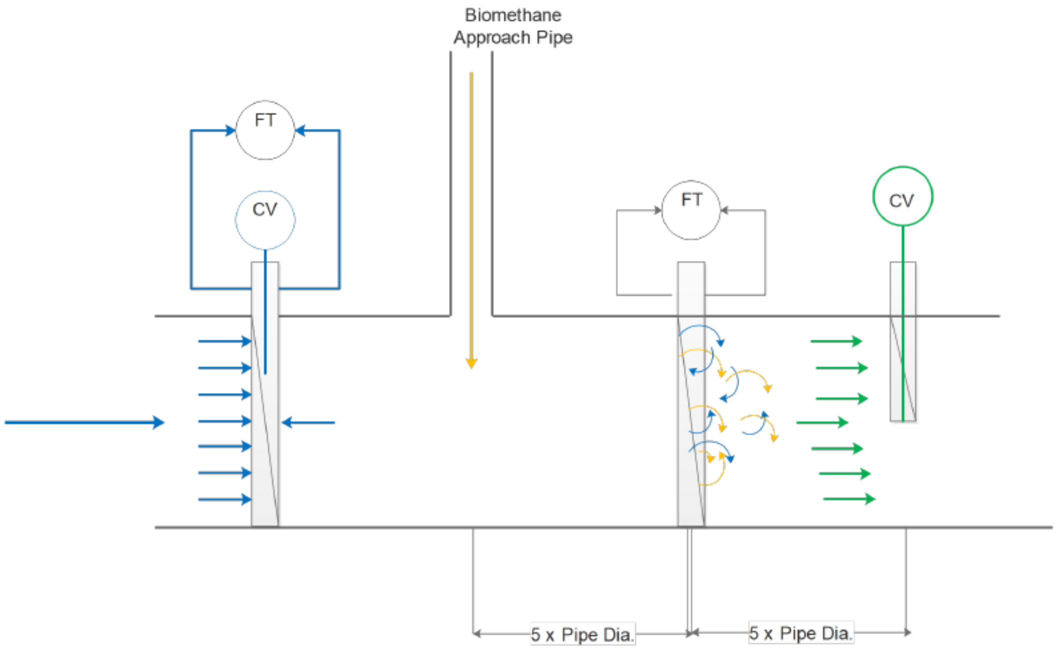


Key

1 over DN300 –12 ” - 100 mm insertion or 10 % of the size of the pipe

2 below DN300 –12” - Location in the centre one-third

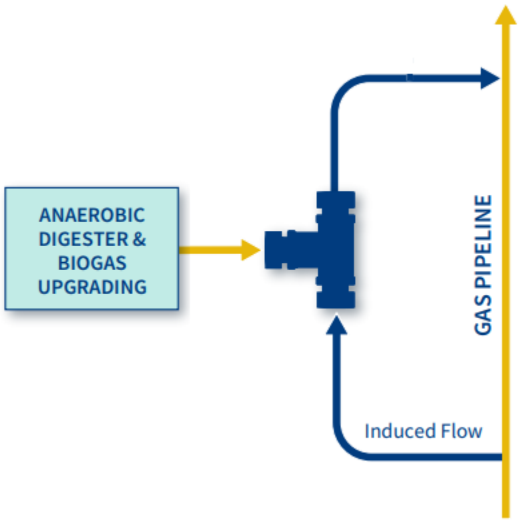
Biomethane is currently injected into the flowing gas stream via a ‘tee’ connection. The location of the sample probe according to ISO10715 would need to be a minimum of 5 pipe diameters downstream of the Connection Point tee. A uniform gas mixture occurs at a minimum distance downstream of 5 pipe diameters. By introducing a flow probe (vortex shedding type) between the biomethane Connection Point and the Blended Point, mixing will be enhanced. The Blended Point would be a minimum of five pipe diameters downstream of this flow probe which itself would be five pipe diameters downstream of the Connection Point. The collective arrangement of instruments at the existing Connection Point will be referred to at the Remote Monitoring Point (RMP). See schematic below for a representation of the proposed arrangement.



Remote monitoring Point (RMP) schematic.

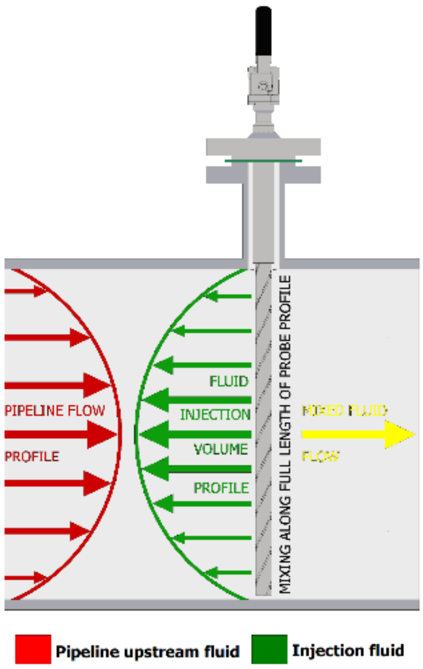
The actual downstream distance to the CV DD will need to be verified in detailed design. If it is subsequently proven or decided that adequate mixing cannot be assured in a standard tee despite seemingly sufficient downstream lengths, then it will be necessary to consider special facilities for introducing the biomethane flow into the network main. These might include a “TeeBlender” (from NZero), a “HyProbe” (from Bohr) or similar approved.

The TeeBlender would require two connections/tappings onto the parent main. These points would then be brought above ground where a gas stream is built with the “Tee Blender” in the middle. The centre of the Tee would be connected to the biomethane export pipe. Other ancillary tapping’s may be required along with full bore isolation valves above ground.



(Simplified) Schematic of NZero TeeBlender (reference Thyson.com)

The Hyprobe solution is connected via a suitable fitting onto the parent main, typically a two to four inch tapping comprising of a full-bore isolation valve, the probe itself would be retractable through the valve for maintenance.



Schematic of Bohr HyProbe (reference Bohr Limited)

For new biomethane connections, solutions of either the TeeBlender or HyProbe type could be considered.

CV Determination Device

The measurement of the CV at the Blending Point will fall under the requirements of an Ofgem directed measurement and as such the CV determination device will be from an Ofgem approved list along with relevant operational / control software. The letter of direction or approval from Ofgem will set out the measurement, calibration, routine testing, and maintenance requirements of the device along with any requirements for on-site visits and verifications by the Gas Examiner. The approved software will determine the end of day average Comingled CV for the Blended Point, and this will be transmitted to SGN Gas Control. If for any reason the operation of the CV DD falls outside operating parameters, it will raise a System 1 alarm which will be sent to Gas Control, this indicates there is a problem with the CV measurement and any values from the device are to be ignored until the alarm condition is rectified. This situation would also require the cessation of blending. The blending algorithm would use a System 1 directly as a trip to full Biomethane Target CV (with CV Offset returning to zero).

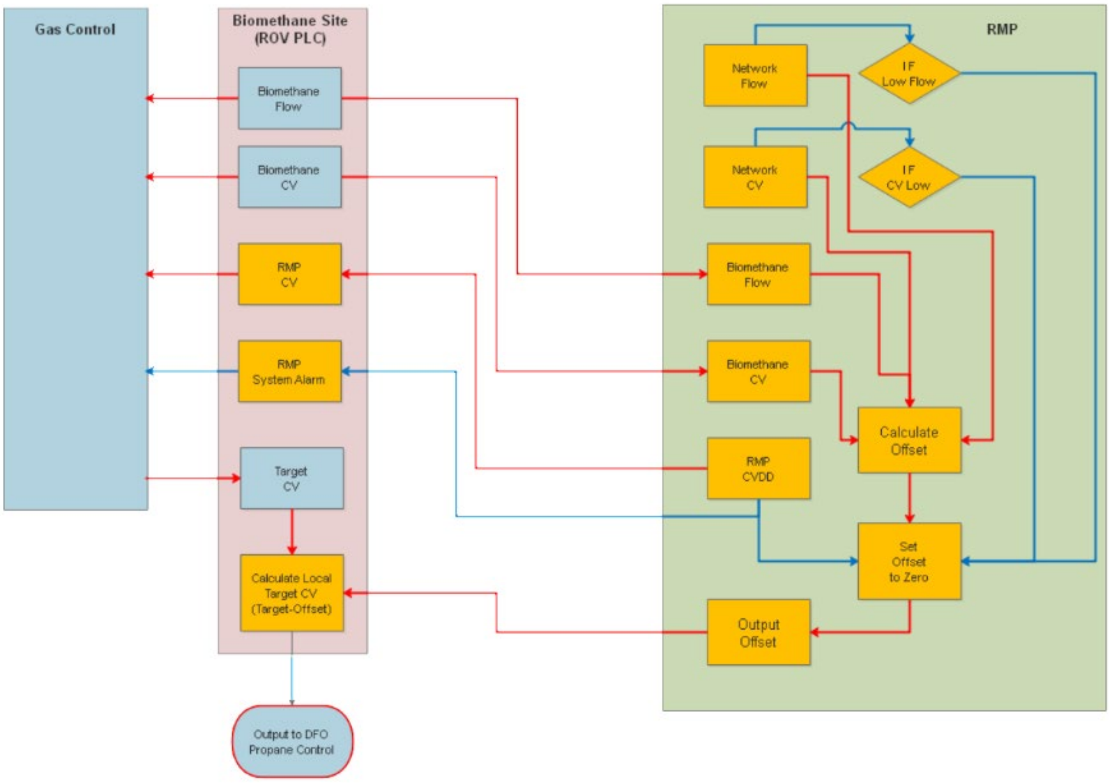
Expanding on the previous point on reverse flow, this is important as a reverse flow would mean that the official Comingled CV measurement at the Blended Point would not be measuring blended gas. The concept solution described herein deals with the reverse flow condition by reducing the Target Offset to zero when the Network Flow is less than a threshold value (set at commissioning). This would obviously include Network Flows < 0 (that would be observed in the case of reverse flow). If reverse flow is expected, then a second official remote CV DD point would need to be installed upstream of the Connection Point, with control changes accordingly.

Target CV Offset

As noted previously, the Offset will be calculated based on prevailing flows/CVs. It is proposed that this Offset be communicated from the RMP PLC to the existing ROV PLC. If the necessary conditions are met, the Offset will be applied in the ROV PLC and Biomethane Target CV being sent to the DFO's GEU will be reduced accordingly (meaning that the need for modifications in the exiting GEU are minimised). Under normal operation, as has been described previously, the calculated Offset will be increased/decreased accordingly and communicated to the ROV PLC which will apply the Offset to the Network CV Target coming from Gas Control. If any of the potential faults discussed above are apparent, then the Offset will be set to zero by the RMP PLC and/or the ROV PLC. The Offset value, Network CV, Network Flow, Combined Flow, Comingled CV and system status (plus any other parameters and alarms deemed necessary) will be added to the telemetry signals between the ROV RTU and Gas Control.

Proposed Data Flow

The figure below details the proposed data flow for the concept solution:



Proposed Data Flow Arrangement

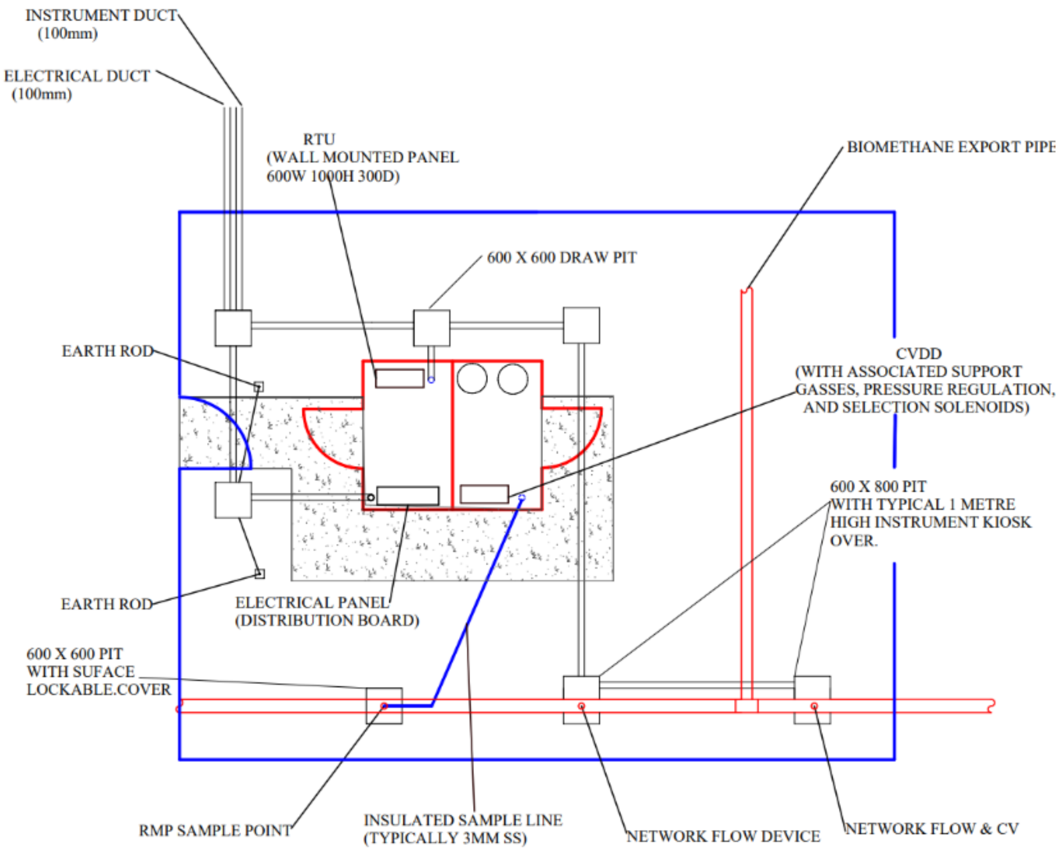
Monitoring signals from the blending point location can either be sent to the existing biomethane site, either by local point to point telemetry or direct hardwired connection. The method of connection would be on a site-by-site basis dependent on local physical constraints. See the Particular Specification for details of considerations.

Proposed Monitoring Facility Layout

As described above, the concept solution will require new instruments on the network main both up and downstream of the existing Connection Point. It is proposed that a RMP Compound be established with an encompassing sampling instrument chambers and a kiosk to house sampling and telemetry hardware.

In all cases, this Connection Point and hence the RMP Compound is likely to be remote (to an extent) from the main biomethane site. In some cases, it will be practical to connect this RMP Compound to the biomethane site via ducts for both LV power supply and comms cables. In others, this will not be practical. As noted above, in the latter case, it should be possible to route signals via a point-to-point (like radio) system. See the Particular Specification for details of acceptable solutions.

The proposed layout for such a remote monitoring installation can be seen below:



Proposed RMP Compound Layout (network flow from right to left).

This layout is shown in project drawing BLD-GEN-DR-M-0001. In the typical arrangement shown above, the monitoring facility compound encompasses the proposed sample point chambers. A 2.4m (CE9) high palisade fence is proposed to offer a level of security. Provision will need to be made for pedestrian access to the compound, as well as parking for a single vehicle within an acceptable distance.

Proposed RMP Kiosk & Control Hardware

Within the RMP Compound, a 3.0 x 3.0 metre standalone walk-in GRP kiosk is proposed, sub divided and sealed into hazardous and safe areas for CV DD and electrical/telemetry equipment respectively. The security rating of the kiosk itself and Abloy lock grade will need to be confirmed. The kiosk will contain electrical power and distribution system, thermostatically controlled space heater, intruder alarm and forced ventilation fan. Kiosk lighting will be low energy type and installed suitable for zone. The electrical room will house a wall mounted panel (1000 x 800mm) to contain the RMP Industrial PC/PLC, compliant with SGN/SP/INE/1. The industrial PC shall be capable of running the Ofgem approved software to control and record the approved CV DD, which will be installed in the adjacent hazardous area side of the kiosk.

The control panel shall also include the RMP PLC, an HMI, I/O modules, network cards and the back-up batteries for the control system. (This should be 12 hours – reference SGN/PM/INE/2). The internal temperature of the panel, under high ambient temperatures, shall be considered when deciding panel size and / or forced ventilation. External ambient temperatures range from –10 to + 40 Degrees C. The designer will also need to ensure the design is compliant with the associated SGN policy and procedure and will need to go through PS6 design approval and appraisal.

The hazardous area side of the kiosk to contain the approved CV DD along with supporting pressure regulation, isolation, and venting equipment. Gas vents shall terminate outside the building at a suitable height with appropriate weather protection. The compartment is to also hold all required calibration, verification, and Ofgem Test gasses, maintained within temperature limits specified in the Letter of Direction / Approval.

All cable ways between the safe and hazardous areas are to be by approved sealing system (e.g. Roxtec). All cable entries from outside the building are to be through buried ducts through the kiosk floor, appropriately sealed.

Proposed Monitoring Facility Instruments

As can be seen in the RMP Compound Layout figure above, the instruments on the network main will be installed (via under-pressure connections as appropriate) either side of the Connection Point on the network main.

For the Network CV / Network Flow (upstream) instrument, a single probe is proposed. A further probe is proposed for the Combined Flow instrument. Rather than the instruments being in a below ground chambers, the detailed design should include a solution where the instruments present above ground level and are housed in a suitable (lockable) cabinet. Flanges/isolation valves can be situated in chambers beneath the proposed cabinets.

For the Network CV measurement, a fast-acting CV measurement device (that is not necessarily from Ofgem approved list) is proposed. A differential pressure measurement device (with temperature and pressure measurement) is proposed to determine Network Flow and Combined Flow. The preference is for 'transmitter' style devices where only intrinsically safe signals are returned to the safe side of the kiosk.

As noted previously, by including the Combined Flow probe downstream of the Biomethane Connection, turbulence caused by the probes' presence which will help to ensure mixing ahead of the downstream Comingled CV measurement at the Blended Point.

A CV DD sample probe is proposed for the Comingled CV measurement. It is proposed that a small-bore sample line (insulated) be ducted back to hazardous side of RMP Kiosk for connection to the CV DD[1]. The Comingled CV DD instrument chamber will hence have to be in relatively close proximity to the RMP Kiosk (whereas the upstream fast-acting Network CV instrument sample chamber could be some distance away if necessary). As the instrument will be in the RMP Kiosk, there is no need for a cabinet over the Comingled CV sample point chamber, so it can simply have a lockable cover.

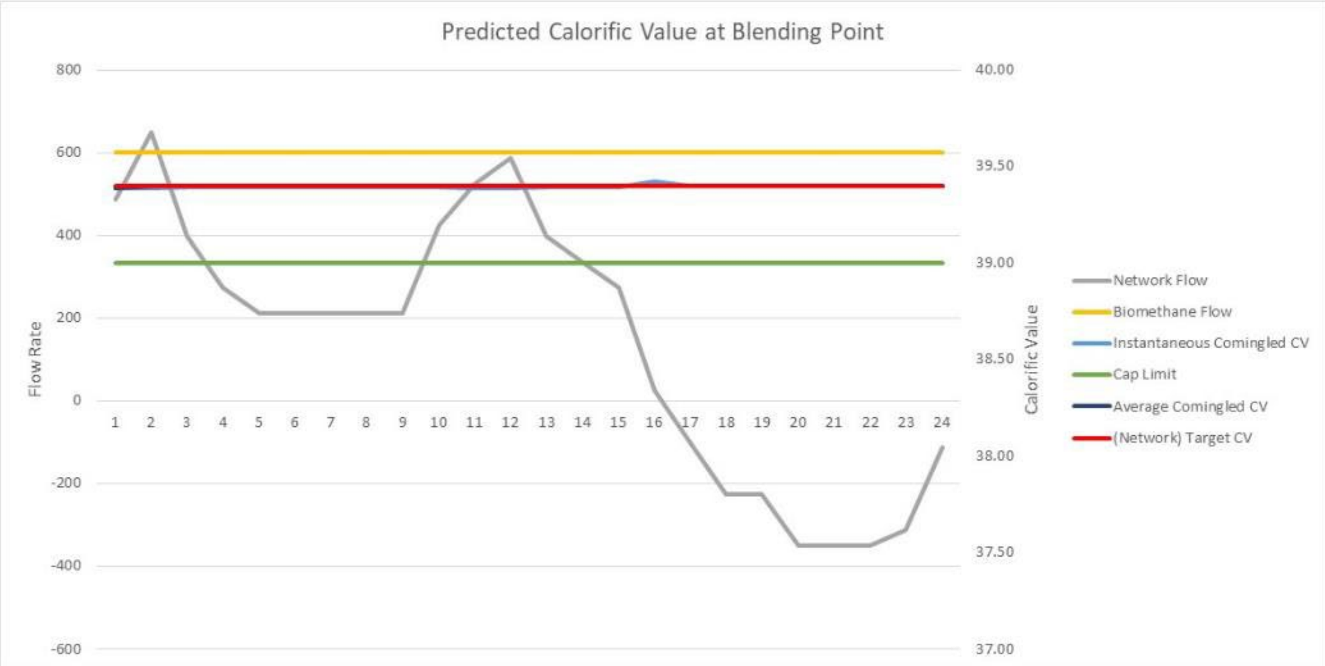
See Section 5 (Particular Specification) for further details, including the onward reference to drawing BLD-GEN-DR-C-0008 that shows a notional arrangement with a cabinet installed over the network main to house the probe mounted instrument head above ground.

[1] In order to help demonstrate that full mixing has been achieved, initial sites could have two downstream CV sample points providing samples to a common instrument that cycles between them. Any discrepancy would indicate potential mixing issues.

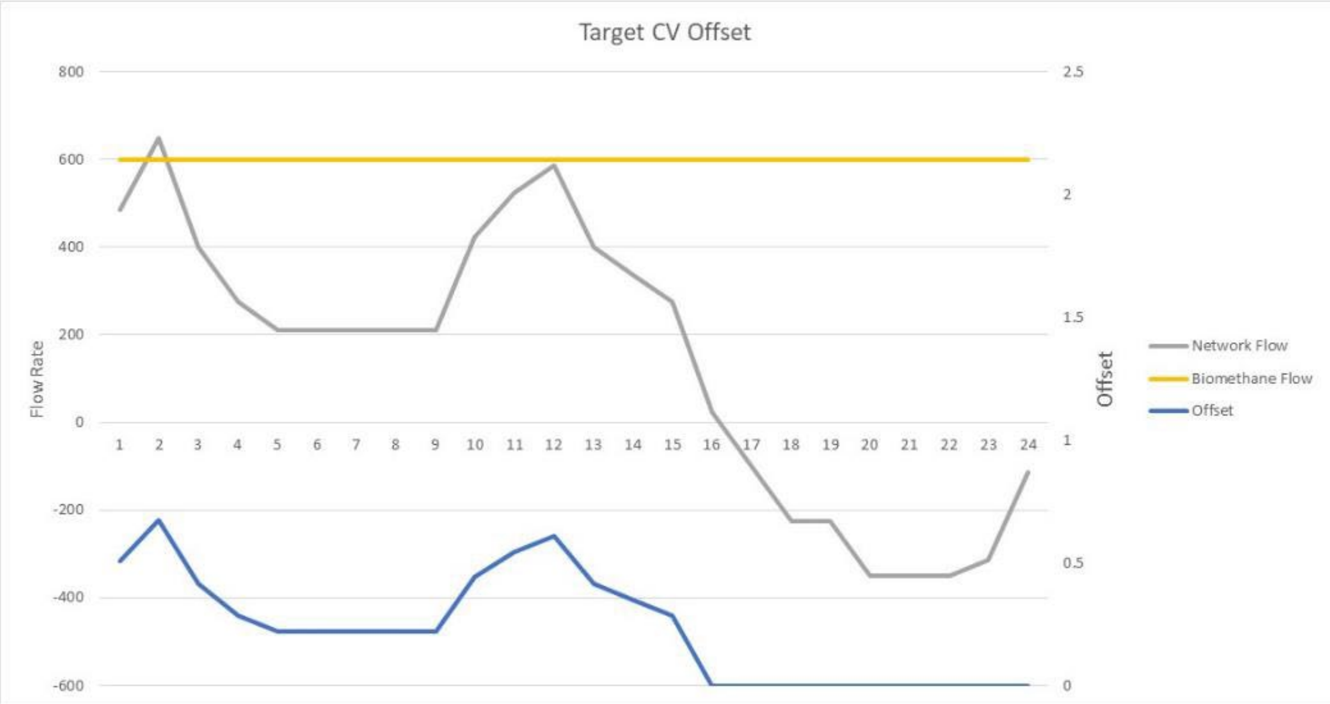
3.3 Concept Impact

This study was asked to consider the potential impact if the concept described above were to be applied at a selection of existing biomethane sites on the SGN networks. The CV Target Offset concept described above was applied to each of the target sites. The setpoints for the algorithm were optimised to ensure there was no risk of breaching the Network Target CV. This was done for all potential instances of network flow (from 10% of maximum to 100% of maximum at SNT).

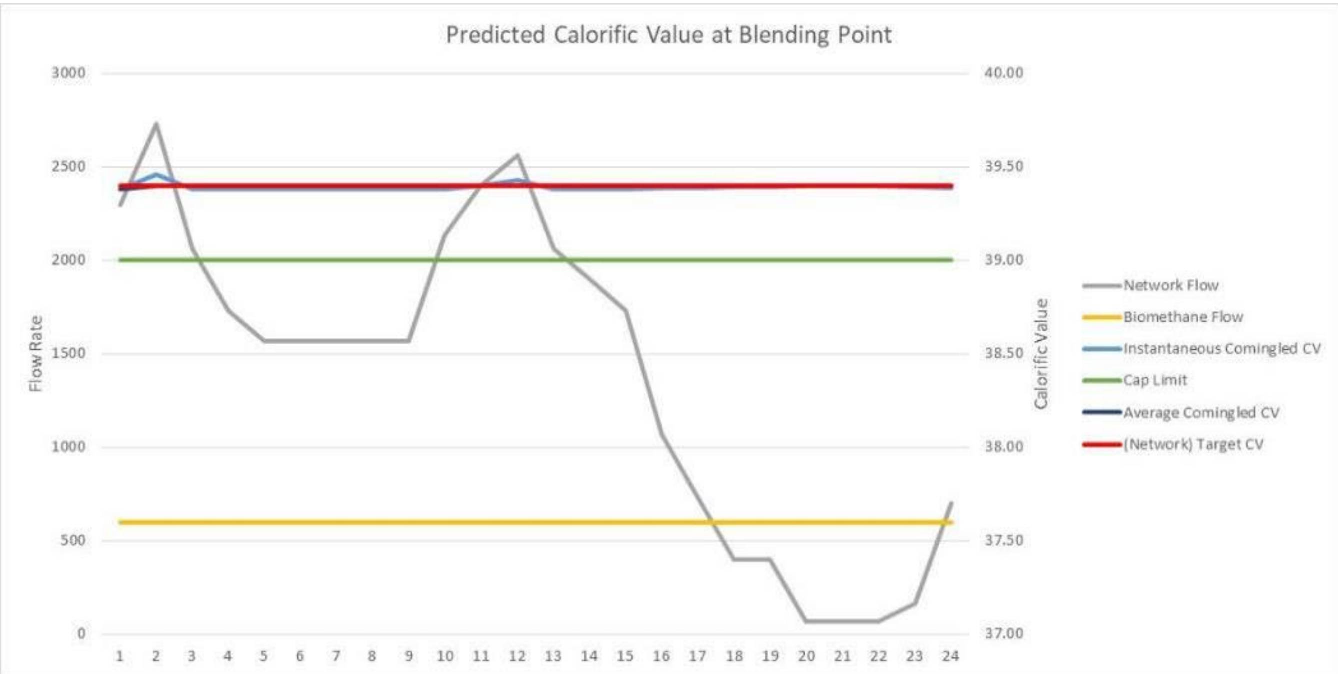
The graphical output below shows the diurnal trend for flow and CV at an example site (Site A) for 30% SNT flow demand:



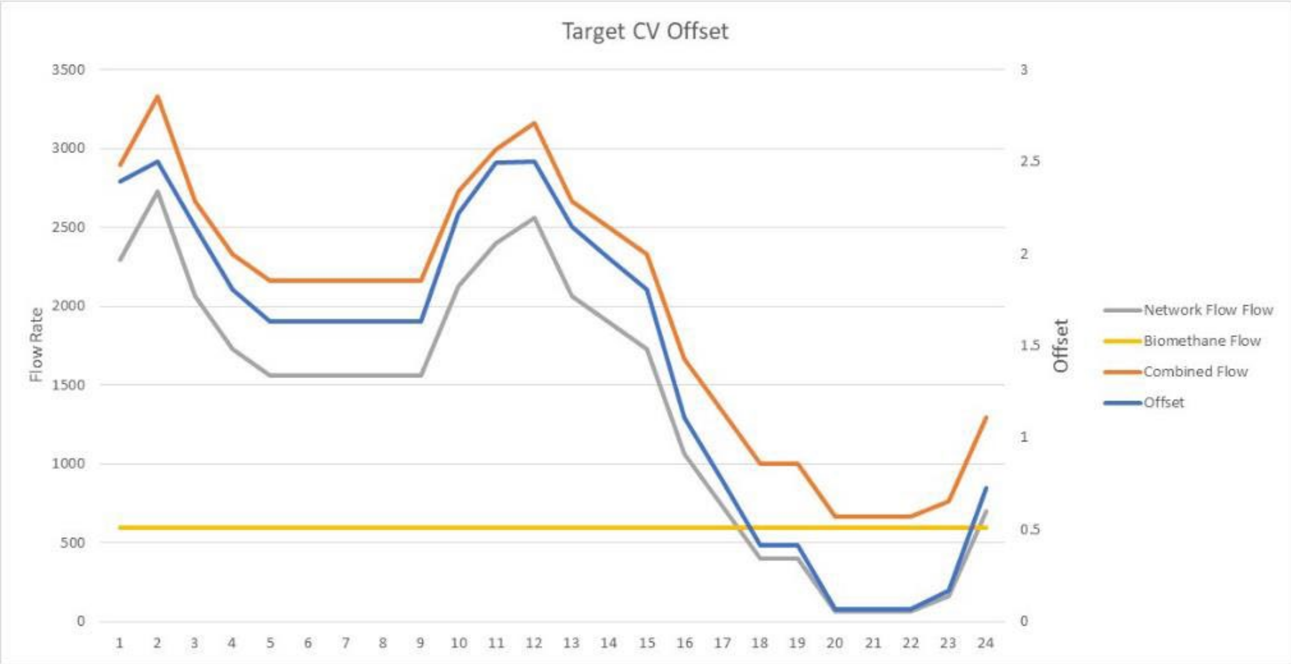
The graphical output below shows the diurnal flow again and recommended CV target offset for this this site at the 30% flow demand:



The graphical output below shows the diurnal trend for flow and CV at an example site (Site A) for 80% SNT flow demand:



The graphical output below shows the diurnal flow again and recommended CV target offset for this this site at the 80% SNT flow demand:



Clearly the opportunity to reduce (via an increasing target CV offset) the amount of propane being saved is higher when the network flow tends towards 100% flow.

The number of hours per year that the network flows at each % of its maximum demand was then reviewed and the potential propane savings at these network flows were calculated using the method above for all target sites. It should be noted again that the SNT demands with reduced industrial loads, so the actual savings are likely to be higher still.

			Demand @ 39.4 Network CV											
	Biomethane Av. Flow	**10%**	**20%**	**30%**	**40%**	**50%**	**60%**	**70%**	**80%**	**90%**	**100%**	**Annual Predicted Propane Reduction %**	**Annual Propane Required Kg**	**Propane Reduction Kg**
Site A	600	0.0%	3.2%	13.8%	23.8%	36.3%	47.8%	57.6%	65.5%	71.1%	73.6%	27.5%	407,668	112,121
Annual weighting (hrs at each demand level)		28	2122	1903	1362	870	916	800	468	249	66			
Site B	1700	0.0%	9.2%	22.4%	36.4%	49.8%	59.9%	66.3%	69.2%	72.0%	74.3%	28.9%	12,460,000	359,640
Annual weighting (hrs at each demand level)		1093	2495	1610	938	745	826	524	363	169	21			
Site C	480	0.0%	0.0%	0.0%	0.8%	4.5%	10.2%	14.4%	19.0%	23.4%	28.7%	1.8%	352,115	6,339
Annual weighting (hrs at each demand level)		1249	2587	1856	1122	1127	583	240	20	0	0			
Site D	680	0.0%	5.5%	17.7%	30.9%	44.8%	56.3%	64.7%	69.9%	72.4%	75.2%	18.5%	553,559	102,593
Annual weighting (hrs at each demand level)		1438	2779	1893	1029	941	469	192	19	0	0			
Site E	1200	0.0%	0.0%	3.9%	12.2%	20.1%	28.6%	36.9%	45.9%	54.4%	61.7%	11.3%	749,929	84,982
Annual weighting (hrs at each demand level)		1088	2582	1232	464	1370	1690	348	10	0	0			
Site F	360	0.0%	0.0%	4.3%	11.8%	19.0%	26.9%	34.5%	42.9%	50.5%	57.2%	4.8%	254,040	12,173
Annual weighting (hrs at each demand level)		2233	3076	1282	1108	742	320	23	0	0	0			
Site G	700	9.5%	39.0%	65.1%	75.9%	81.8%	86.5%	89.2%	91.3%	92.7%	94.0%	58.5%	475,595	278,118
Annual weighting (hrs at each demand level)		1093	2495	1610	938	745	826	524	363	169	21			
Site H	670	4.5%	28.3%	53.3%	70.1%	76.8%	81.6%	85.9%	88.2%	90.4%	91.7%	69.0%	455,155	313,949
Annual weighting (hrs at each demand level)		303	620	1317	1296	1752	1073	700	854	456	296			

Based on the deployment of the proposed concept, the potential aggregated benefit for propane blending at each site could be considered and compared to the Blending Study conclusions.

Assessment:		**Blending Study**			**Concept Impact**		
Site	**Av. Biomethane Flow**	**Propane Annual Tonnes (No Blending)**	**Propane Annual Tonnes (savings) (Blending)**	**Propane Saving %**	**Propane Annual Tonnes (No Blending)**	**Propane Annual Tonnes (savings) (Blending)**	**Propane Saving %**
Site A	**600 Sm3/hr**	**401**	**148**	**36.9 %**	**407**	**112**	**27.5 %**
Site B	1700 Sm3/hr	998	420	42.0 %	1246	360	28.9 %
Site C	480 Sm3/hr	265	15	5.8 %	352	6.3	1.8 %
Site D	680 Sm3/hr	458	169	36.9 %	553	102.5	18.5 %
Site E	1200 Sm3/hr	744	166	22.3 %	750	84.9	11.3 %
Site F	360 Sm3/hr	189	29	15.5 %	254	12.1	4.8 %
Site G	560 scm3/hr	362	284	78.4%	476	197	58.5%
Site H	600 scm3/hr	322	212	66.0%	455	141	69%

As noted in Section 2.1, the savings estimated savings in the Blending Studies are based on theoretical values and no allowance has been applied for system operational performance or tolerance. The proposed concept deploys a practical solution with a simple control system. Optimisation of this control system may be possible in detailed design, and this may help to further improve the propane savings. Examples of such optimisation initiatives include the option to fully turn off propane at some sites in certain conditions (see Section 3.2) and the option to allow the Comingled CV to ‘droop’ for short periods in any given gas day (see Section 3.1).

Based on the negligible benefit (and complexities regarding the existing Connection Point), it was agreed that a concept deployment would not be developed for the St Boswells site.

4 Solution Deployment

This Section considers how the concept solution presented above might, in the case of each site, be deployed and what the indicative implementation and ongoing operational costs might be. Risks and opportunities specific to each site are also discussed. Particular details for the system components (like bases, kiosks, instruments etc) are included in Section 5 (Particular Specification).

4.1 Site A

The following considerations are applicable to the Site A and have influenced the deployment of the concept solution accordingly.

Site Overview

The figure below shows the existing biomethane plant and its connection to the local gas network.

Redacted figure

Site A Existing Layout

See drawing 'BLD-A-DR-M-0003 - SGN Infrastructure Plan' for reference. The 100m PE export connection from Site A biomethane site crosses a minor road and connects to a 200mm steel IP (7 bar) network main. The connection point is in a field that is not currently developed.

Land and Access

SGN Legal department will deal with land negotiations:

Third Party Services

This study requested details for the local area via Line Search and DigDat. The table below lists the utility/service drawings that were received in response.

Line Search Outputs	
BLD-A-DR-E-0004	Electricity DNO Plan - SSE
BLD-A-DR-E-0005	Telecoms Plan – NEOS Networks
BLD-A-DR-M-0006	IGT Infrastructure Plan – Indigo Pipelines
BLD-A-DR-C-0007	Dig Dat Search
BLD-A-DR-C-0008	Line Search Overview
BLD-A-DR-E-0009	SSE Enterprise DNO Plan

Further service searches and investigative works will be required as the project progresses into detailed design and construction.

Proposed Configuration

The figure below shows the proposed layout for the remote monitoring facility at Site A in the context of the existing biomethane plant and network connection.

Redacted layout

Proposed Layout (BLD/A/DR/M/0001)

This layout above can be found in project drawing SGN/BLD/A/M/0001. Given the easement for the network main, the kiosk is offset 3m and has been positioned on the road-side between the gas main and the road. The proposed chambers (still within the proposed compound) are on the opposite side of the kiosk.

Being a steel main, welded connections are proposed for the new instruments. See mechanical requirements in Section 5.4 of the Particular Specification section below for details.

It is proposed that LV power and communications cables be run via new ducts from the DFO site to the RMP compound. This will mean crossing the road with the twin 100mm ducts and finding a route through the DFO site to the ROV.

Site Specific Risks & Opportunities

See document 'BLD-GEN-SCH-0002 - Design Risk Register' for details for generic technical and SHE risk identified at concept phase.

Apart from the road crossing and new layby, the scope for Site A is considered relatively uncontentious. There is hence an opportunity to prioritise this site as one of the earlier projects.

Based on (Google maps) satellite imagery, there is a possibility that development is proposed/underway in the area adjacent to the proposed location for the RMP kiosk. This should be investigated.

4.2 Site B

The following considerations are applicable to the Site B and have influenced the deployment of the concept solution accordingly.

Overview

The figure below shows the existing Site B biomethane plant and its connection to the local gas network.

Redacted layout

Site B existing layout

See drawing 'BLD-B-DR-M-0003 - SGN Infrastructure Plan' for reference. The 180m HDPE export connection from the biomethane site crosses the AD site owner's field and connects into the 16" IP steel main.

Land and Access

SGN Legal department will deal with land negotiations.

Third Part Services

This study has requested details for the local area via Line Search and DigDat. The table below lists the utility/service drawings that were received in response.

Line Search Outputs	
BLD-B-DR-E-0004	Electricity DNO Plan - SSE
BLD-B-DR-C-0007	Dig Dat Search Output
BLD-B-DR-C-0008	Line Search Overview

Further service searches and investigative works will be required as the project progresses into detailed design and construction.

Proposed Configuration

The figure below shows the proposed layout for the remote monitoring facility at Site B in the context of the existing biomethane plant and network connection.

Redacted layout

Proposed Layout (BLD/B/DR/M/0001)

This layout is shown in project drawing BLD/B/DR/M/0001. Given the AD operator owns the land between the AD site and the receiving main, there should be limited complications with the development of the blending site facility. As can be seen in project drawing BLD/B/DR/M/0001, the fact that the receiving main is 16" dictates that the official CV measurement must be relatively far from the existing connection. As such, the compound has been configured accordingly.

Being a steel main, welded connections are proposed for the new instruments. See mechanical requirements in Section 5.4 of the Particular Specification section below for details.

The Connection Point is in a field so a layby on the AD site's access road is proposed with a 50m long footpath for pedestrian access to the RMP compound.

It is proposed that LV power and communications cables be run via new ducts from the DFO site to the RMP compound (as the route between the AD site and the RMP is entirely on the AD operator's land). Initial discussions with the AD operator/landowner suggest there may however be more convenient options for an LV power supply to the RMP kiosk.

Site Specific Risks & Opportunities

See document ‘BLD-GEN-SCH-0002 - Design Risk Register’ for details for generic technical and SHE risk identified at concept phase.

Given the RMP Compound area and route back to the ROV is all within the DFO’s land ownership, there should be limited challenges when implementing the Concept Solution at this site. The DFO is very proactive and may well be willing to assist with or take on elements of the scope in order expedite delivery. As noted above, the option to find an alternative power supply and/or existing duct runs may yield significant savings over the current estimates.

4.3 Site C

The following considerations are applicable to the Site C and have influenced the deployment of the concept solution accordingly.

Site Overview

The figure below shows the existing biomethane plant and its connection to the local gas network.

Redacted layout

Friday Farm Existing Layout

See drawing 'BLD-C-DR-M-0003 - SGN Infrastructure Plan' for reference.

The PE export connection from the Site C biomethane site crosses the site's access road and connects to 213mm PE main that record show is inserted in a 9" cast iron main. The export main can be seen to follow the site's access road and then double back to the connection point on the edge of the field.

Land and Access

SGN Legal department will deal with land negotiations.

Third Party Services

This study has requested details for the local area via Line Search and DigDat. The table below lists the utility/service drawings that were received in response.

Line Search Outputs	
BLD-C-DR-E-0004	Electricity DNO Plan – UKPN
BLD-C-DR-C-0005	Dig Dat Search Output
BLD-C-DR-C-0006	Line Search Overview

Further service searches and investigative works will be required as the project progresses into detailed design and construction.

Proposed Configuration

The figure below shows the proposed layout for the RMP Compound at Site C in the context of the existing biomethane plant and Biomethane Connection.

Redacted layout

Proposed Layout (BLD/C/DR/M/0001)

This layout above can be found in project drawing SGN/C/DR/M/0001. As the network main and biomethane connection appear relatively tight to the road, the RMP Compound is proposed beyond, with a parking space adjacent.

It is proposed that LV power and communications cables be run via new ducts from the DFO site to the RMP compound (as the route between the AD site and the RMP is entirely on the AD operator’s land).

Being a PE service within an original cast iron main, suitable techniques for establishing instrument connections will need to be employed. See mechanical requirements in Section 5.4 of the Particular Specification section below for details.

Risks & Opportunities

See document ‘BLD-GEN-SCH-0002 - Design Risk Register’ for details for technical and SHE risk identified at concept phase.

The main risk for Site C appears to be around the fact that the network main is PE inserted within a 9” cast iron service. It is assumed that the biomethane connection works will have exposed the PE main within, but the extent of the exposed section is not known and hence the scope for the work required to establish the new connections (for the RMP) is not fully understood at this time. It is also understood that 213mm PE fittings are difficult to source.

4.4 Site D

The following considerations are applicable to the site D and have influenced the deployment of the concept solution accordingly.

Site Overview

The figure below shows the existing biomethane plant and its connection to the local gas network.

Redacted layout

Site D Existing Layout

See drawing 'BLD-D-DR-M-0003 - SGN Infrastructure Plan' for reference. The 180mm HDPE export connection from the Hill Farm is routed along a site access road and connects onto a 16" steel IP (7 bar) network main. The connection point is in an area that is not currently developed.

Land and Access

SGN Legal department will deal with land negotiations.*Land Reference Plan*

Third Party Services

This study has requested details for the local area via Line Search and DigDat. The table below lists the utility/service drawings that were received in response.

Line Search Outputs	
BLD-D-DR-E-0004	Broadband DNO Plan
BLD-D-DR-C-0005	Dig Dat Search Output
BLD-D-DR-E-0006	Electricity DNO Plan
BLD-D-DR-C-0007	Line Search Overview

Further service searches and investigative works will be required as the project progresses into detailed design and construction.

Proposed Configuration

The figure below shows the proposed layout for the remote monitoring facility at Site D in the context of the existing biomethane plant and network connection.

Redacted layout

Proposed Layout (BLD/D/DR/M/0001)

This layout above can be found in project drawing SGN/D/DR/M/0001. It appears there is sufficient space between the main and the site access road to accommodate the RMP Compound. Given the proximity to the DFO site, a dedicated parking area is not proposed. It is proposed that LV power and communications cables be run via new ducts from the DFO site to the RMP compound. No road crossings are required.

The depth of cover to the 16” IP steel network main at Hill Farm is known to be significant, possibly up to 4m depth. It is also apparent that the 16” IP main runs in parallel to a 24” HP gas main with the potential for girth weld defects to be present and will require appropriate SW2 plant protection measures to be deployed whilst works are within the proximity of the HP pipeline. These elements will add complexity and costs to both the design and implementation phases of the project.

Being a steel main, welded connections are proposed for the new instruments. See mechanical requirements in Section 5.4 of the Particular Specification section below for details. Given the depth of cover, special consideration will need to be made regarding the arrangements for sample probes and sample line connections. It may even be necessary to employ man access chambers for these instruments.

Risks & Opportunities

See document ‘BLD-GEN-SCH-0002 - Design Risk Register’ for details for technical and SHE risk identified at concept phase.

As noted above, the 16” IP main is relatively close to a 24” HP SGN main at the Connection Point. Additional procedures therefore will apply, including the requirement for construction works to be supervised by an SW2 inspector. Some records suggest that the vintage of the IP and HP pipelines may mean there are risks of Girth Weld defects and subsequently works must be undertaken in accordance with T/PR/P18 – working on pipelines containing defective girth welds or girth welds of unknown quality. Further investigation (ahead of implementation) is recommended. Again, as noted above, the depth of over for the IP main will also create elevated levels of cost, complexity and construction phase risk.

4.5 Site E

The following considerations are applicable to site E and have influenced the deployment of the concept solution accordingly.

Site Overview

The figure below shows the existing biomethane plant and its connection to the local gas network.

Redacted layout

Site E Existing Layout

See drawing 'BLD-E-DR-M-0003 - SGN Infrastructure Plan' for reference. The PE export connection from the Icknield biomethane site crosses a field and connects to a 400mm steel IP (7 bar) network main. The connection point is in a field that is not currently developed.

Land and Access

SGN Legal department will deal with land negotiations.

Third Party Services

This study has requested details for the local area via Line Search and DigDat. The table below lists the utility/service drawings that were received in response. (Line Search recorded no services for the site E).

Line Search Outputs	
BLD-E-DR-C-0004	Dig Dat Search Output
BLD-E-DR-M-0005	National Gas Infrastructure Plan
BLD-E-DR-C-0006	Line Search Overview
BLD-E-DR-E-0007	Electricity DNO Plan

Further service searches and investigative works will be required as the project progresses into detailed design and construction.

Proposed Configuration

The figure below shows the proposed layout for the remote monitoring facility at Site E in the context of the existing biomethane plant and network connection.

Redacted layout

Proposed Layout (BLD/E/DR/M/0001)

This layout above can be found in project drawing SGN/E/DR/M/0001. The Connection Point is in an undeveloped field, with sufficient space for the proposed RMP Compound. It is proposed that LV power and communications cables be run via a short run of new ducts from the DFO site to the RMP compound. Given the proximity to the DFO site, it is proposed that legacy access arrangements include parking at the DFO site and a pedestrian route to the compound. The biomethane export pipeline is 180mm HDPE, connecting to a 16” steel IP pipeline. Therefore, any connections proposed for the new instruments would need to be welded. See mechanical requirements in Section 5.4 of the Particular Specification section below for details.

Risks & Opportunities

See document ‘BLD-GEN-SCH-0002 - Design Risk Register’ for details for technical and SHE risk identified at concept phase.

SGN records suggest that the vintage of the IP main may mean P18/Girth Weld risks apply. Additional procedures therefore will apply, including the requirement for construction works to be supervised by an SW2 inspector. Records suggest that the vintage of the IP pipeline may precede 1972 and this pipeline has operated within its lifetime at pressures in excess of 7 bar, meaning there are risks of Girth Weld defects and subsequently works must be undertaken in accordance with T/PR/P18 – working on pipelines containing defective girth welds or girth welds of unknown quality.

4.6 Site F

The following considerations are applicable to the site F and have influenced the deployment of the concept solution accordingly.

Site Overview

The figure below shows the existing biomethane plant and its connection to the local gas network.

Redacted layout

Site F Existing Layout

See drawing 'BLD-F-DR-M-0003 - SGN Infrastructure Plan' for reference.

The PE export connection from the Isle of Wight biomethane site crosses number of fields and then a minor road to connect onto an 18" Spun Iron MP (1 bar) network main. The connection point is on the edge of a field that is not currently developed.

Land and Access

SGN Legal department will deal with land negotiations.:

Third Party Services

This study has requested details for the local area via Line Search and DigDat. The table below lists the utility/service drawings that were received in response. (Line Search returned no results for the site F).

Line Search Outputs	
BLD-F-DR-C-0004	Dig Dat Search Output
BLD-F-DR-C-0005	Line Search Overview

Further service searches and investigative works will be required as the project progresses into detailed design and construction.

Proposed Configuration

The figure below shows the proposed layout for the remote monitoring facility at Site F in the context of the existing biomethane plant and network connection.

Redacted layout

Proposed Layout (BLD/F/DR/M/0001)

This layout above can be found in project drawing SGN/F/DR/M/0001. The biomethane export main actually crosses the road to connect into the network main running across the field. A parking area and RMP Compound is proposed to the South of the network main.

Given the relatively large distance between the DFO site and the RMP and given the number of landowners/lease holders involved, it is proposed that an alternative (DNO) LV power supply is secured for the RMP Compound. A wireless communications link will also hence be required.

Being a spun iron main, suitable techniques for establishing instrument connections will need to be employed. See mechanical requirements in Section 5.4 of the Particular Specification section below for details.

Risks & Opportunities

See document 'BLD-GEN-SCH-0002 - Design Risk Register' for details for technical and SHE risk identified at concept phase.

The availability of a convenient DNO LV power supply for the RMP Compound is yet to be confirmed. The technical viability of a wireless communications link is also still subject to formal approval.

4.7 Site G

The following considerations are applicable to the site G and have influenced the deployment of the concept solution accordingly.

Site Overview

The figure below shows the existing biomethane plant and its connection to the local gas network.

Redacted layout

Site G Existing Layout

The PE export connection from the Site G biomethane site is routes through an industrial estate area and crosses a minor road to connect to a 200mm steel IP (7 bar) network main. The connection point is in a field that is not currently developed. There is a customer connection within 10m of the Connection Point. To mitigate this, the customer connection will either have to be moved, or the customer will have to be switched onto an alternative (energy based) billing arrangement.

Land and Access

SGN Legal department will deal with land negotiations.

Third Party Services

This study has requested details for the local area via Line Search and DigDat. The table below lists the utility/service drawings that were received in response.

Line Search Outputs	
BLD-G-DR-E-0004	Electricity DNO Plan - SSE
BLD-G-DR-C-0005	Dig Dat Search Output
BLD-G-DR-C-0006	Line Search Overview

Further service searches and investigative works will be required as the project progresses into detailed design and construction.

Proposed Configuration

The figure below shows the proposed layout for the remote monitoring facility at Riverside in the context of the existing biomethane plant and network connection.

Redacted layout

Proposed Layout (BLD/G/DR/M/0001)

This layout above can be found in project drawing SGN/RIV/DR/M/0001. It is proposed that the RMP Compound be beyond the network main, with a parking area alongside. Being a steel main, welded connections are proposed for the new instruments. See mechanical requirements in Section 5.4 of the Particular Specification section below for details. Due to relatively convoluted route and multiple landowners/lease holders, a new DNO LV supply is proposed, along with a wireless communications link back to the DFO site.

Risks & Opportunities

See document BLD-GEN-SCH-0002 - Design Risk Register for details for technical and SHE risk identified at concept phase.

As noted above, there is a customer connection within 10m of the Connection Point. Although this appears relatively easy to mitigate, the approach still needs to be agreed.

The availability of a convenient DNO LV power supply for the RMP Compound is yet to be confirmed. The technical viability of a wireless communications link is also still subject to formal approval. Given the DFO site appears to be on an industrial estate, there may be an existing duct network that could provide a route/partial route between the RMP Compound and the DFO site. This presents a potential opportunity should it be found to be necessary to route LV and/or communications between the two locations.

4.8 Site H

The following considerations are applicable to the site H and have influenced the deployment of the concept solution accordingly.

Site Overview

The figure below shows the existing biomethane plant and its connection to the local gas network.

Redacted layout

Site H Existing Layout

See drawing 'BLD-H-DR-M-0003 - SGN Infrastructure Plan' for reference. The PE export connection from Site H biomethane site crosses a minor entrance road and connects to a 250mm PE MP (2 bar) network main. The connection point is to the side of a minor road.

Land and Access

SGN Legal department will deal with land negotiations.

Third Party Services

This study requested details for the local area via Line Search and DigDat. The table below lists the utility/service drawings that were received in response.

Line Search Outputs	
BLD-H-DR-E-0004	Electricity DNO Plan - UKPN
BLD-H-DR-C-0005	Dig Dat Search Output
BLD-H-DR-C-0006	Line Search Overview

Further service searches and investigative works will be required as the project progresses into detailed design and construction.

Proposed Configuration

The figure below shows the proposed layout for the remote monitoring facility at Site H in the context of the existing biomethane plant and network connection.

Redacted layout

Proposed Layout (BLD/H/DR/M/0001)

This layout above can be found in project drawing SGN/H/DR/M/0001. The Connection Point is immediately opposite the DFO site, and it appears the RMP Compound can be accommodated adjacent to the product storage clamps. The network main is PE and MP (2 bar). See mechanical requirements in Section 5.4 of the Particular Specification section below for details.

It is proposed that LV power and communications cables be run via a very short run of new ducts from the DFO site to the RMP compound.

Risks & Opportunities

See document BLD-GEN-SCH-0002 - Design Risk Register for details for technical and SHE risk identified at concept phase.

Given how close the Connection Point is and that land ownership/planning are unlikely to present issues, the Sheppey site could be prioritised for early delivery. However, the exact location of the Connection Point will need to be determined as the product storage clamp structure might clash with the proposed RMP Compound layout.

It is also noted that the flow conditions for the network main are unusual (versus other sites). The flow in the network main is rarely at the low or high end of the flow range. Although there may be a reasonable explanation for this, further investigation is recommended.

5 Particular Specification

This Particular Specification section includes information and references that will be applicable in the subsequent phases of any projects where the blending concept it being rolled out. The term “the Contractor” is used to describe the entity responsible for:

- Development of the detailed design;
- Ratification of the design;
- Procurement and installation of all equipment and elements;
- Testing and commissioning;
- Documentation for handover.

These activities are referred to collectively as “the Works”.

At this time, it is assumed that SGN (or a nominated representative) will progress the following aspects based on the concept designs described herein:

- Land and access (including lease agreements for RMP compounds);
- Easements for new duct runs between the DFO and RMP;
- New DNO power supplies (where a supply from the DFO is not currently deemed practical);

The ownership of risks associated with the following aspects will, until agreed otherwise, remain with SGN:

- Contaminated land;
- Particularly unfavourable geotechnical conditions;
- Buried 3rd party services extra to those detailed in this document.

The responsibilities identified above will be further detailed in the instructions that accompany any invitation to tender for the Works.

5.1 Overview

The development of the design and implementation of the solution at each site shall be undertaken in accordance with all legislative requirements. The Contractor's attention is brought to the following key legislation and design management standards:

Key Legislation & Design Management Standards
Construction (Design and Management) Regulations (CDM): 2015
Health and Safety at Work Act (HASWA): 1974
Gas Safety (Management) Regulations (GSMR): 1996
The Gas Act 1996
Pipeline Safety Regulations 1996
Pressure System Safety Regulations 2000
The Environmental Impact Assessment Directive (85/337/EEC)
The Public Gas Transporters Pipeline works Regulations 1999
Manage the Design in line with the requirements of ISO standards 9001, 14001 and 45001
BS 7000 Part 4

5.2 Standards and Reference Specifications

The development of the design and implementation of the solution at each site shall be undertaken in accordance with all relevant standards and specifications. The Contractor's attention is brought to the following key sets of standards and specifications:

Institution of Gas Engineers & Managers	
IGEM/TD/1 Supplement 1 Edition 2	Handling transport and storage of steel pipe and fittings
IGEM/TD/3 Edition 5	Steel and polyethylene (PE) pipelines for gas distribution
IGEM/TD/13 Edition 2	Pressure Regulating Installations for Natural Gas, Liquid Petroleum Gas (LPG) and LPG/air
IGEM/TD/16 Edition 2	Biomethane Injection
IGEM/TD/17	Steel and polyethylene (PE) pipelines for biogas distribution
IGEM/SR/25 Edition 2	Hazardous area classification of natural gas installations
IGEM/GL/5 Edition 3	Managing new works, modifications and repairs

Gas Industry Standards	
GIS/F7	Specification for carbon and carbon manganese steel forgings and forged components for operating pressures not greater than 7 bar
GIS/V7	Part 1 Specification for Distribution valves, Part 1: Metal-bodied line valves for use at pressures up to 16 bar and construction valves for use at pressures up to 7 bar
SGN/GIS/V6	Steel Valves for Use with Natural Gas at Normal Operating Pressures Above 7 Bar and sizes above DN15 (supplementary to EN 13942:2009)
GIS/VA1	Fluid powered actuators for two position (open/closed) quarter turn valves
GIS/L2	Specification for Steel Pipe 21.3mm to 1219mm Outside Diameter for Operating Pressures up to 7 Bar
GIS/V6	Specification for Steel Valves for use with Natural Gas at Normal Operating Pressures above 7 Bar and sizes above DN15 (This specification also covers below 7 bar valves less than DN80)
IDN/SP/P/1	Specification for Welding of Onshore Steel Pipelines designed to operate at Pressures not greater than 7 Bar
IDN/SP/P/9	Specification for the Welding of Fittings to Pipelines operating under pressure
GIS/F7	Specification for steel welding pipe fittings 15mm to 450mm inclusive nominal size for operating pressures not greater than 7 bar
GIS/TE/P6.3	Specification for Equipment used in testing gas mains and gas services with operating pressures not greater than 7 bar

SGN Standards	
SGN/SP/BIO/2	Specification for Biomethane Network Entry Facility, Remotely Operable Valve and Controls
SGN/PM/MSL/Part 1	Management Procedure for Distribution Main laying and Service laying Activities
SGN/PM/MSL/1 Part 2	Management procedure for specialist Main laying activities
SGN/WI/ML/2	Work Instruction for Main laying up to and including 630mm Diameter and pressures up to 7bar
SGN/PM/PS/5	Management Procedure for the Management of New Works, Modifications and Repairs
SGN/PM/PS/6 Part 1 to 3	Work instruction for managing risk to New works, Modifications and repairs
SGN/SP/B/12	Specification for Steel Bends, Tees, Reducers and End Caps for Operating Pressures Greater Than 7 bar (This specification also covers below 7 bar fittings greater than 450mm)
SGN/SP/MPQ/2	Specification for Manufacturing Procedure Qualification of Steel Bends, Tees, Reducers and End Caps to Transco Specification SGN/SP/B/12

SGN/SP/CE/1	Specification for the Design, Construction, and Testing of Civil and Structural Works - General Structural Design
SGN/SP/CE/3	Specification for the Design, Construction, and Testing of Civil and Structural Works - Concrete
SGN/SP/CE/4	Specification for the Design, Construction, and Testing of Civil and Structural Works - Steelworks
SGN/SP/CE/5	Specification for the Design, Construction, and Testing of Civil and Structural Works - Roads
SGN/SP/CE/6	Specification for the Design, Construction, and Testing of Civil and Structural Works - Drainage
SGN/SP/CE/9	Specification for the Design, Construction, and Testing of Civil and Structural Works - Security Fencing
SGN/SP/CE/10	Specification for the Design, Construction, and Testing of Civil and Structural Works - Enclosures and Pit Covers
SGN/SP/CE/12	Specification for the Design, Construction, and Testing of Civil and Structural Works - Pipeline Protection Slabs
SGN/SP/CW/5	Specification for Field Applied External Coatings for Buried Pipework and Systems
SGN/SP/CW/6 Part 1	Specification for the External Protection of Steel Line Pipe and Fittings Using Fusion Bonded Powder and Other Coating Systems Part 1 – Requirements for Coating Materials and Methods of Test
SGN/SP/CW/6 Part 2	Specification for the External Protection of Steel Line Pipe and Fittings Using Fusion Bonded Powder and Other Coating Systems Part 2 – Factory Applied Coatings
SGN/SP/F/1	Specification for Carbon and Carbon Manganese Steel Forgings and Forged Components for Operating Pressures Greater Than 7 Bar
SGN/SP/F/4	Specification for Hot Tap and Stopping Off Connections for > 70 bar
SGN/SP/NDT/2	Specification for Non-Destructive Testing of Welded Joints on Construction and Fabrication Projects
SGN/PM/ECP/2	Management procedure for Cathodic protection of Buried Steel Piping systems
IDN/SPECP/3	Specification for the Management of DC stray current interference
IDN/SP/P/1	Specification for welding of steel pipelines designed to operate at pressures not greater than 7bar including BS4515
SGN/PM/INE/3	Management Procedure for Selection of Telemetry Points to Operate the SGN Gas Supply System
SGN/PM/INE/4	Management Procedure for the Lifecycle Management of SGN's Alarm and Telemetry Systems
T/PR/SW/1	Work procedure For Excavations
SGN/WI/SW/2	Work Instruction for Safe Working in the Vicinity of Pipelines & Associated Installations with maximum operating pressure >7barg
SGN/PM/SW/3	Management procedure for the use of Mechanical Excavating Equipment
SGN/PM/INV/1	Management Procedure for Incident Reporting and Investigation
SGN/PM/SHE/03	Management Procedure for the Construction (Design and Management) Regulations
T-SGN/SP/TR 21 to 24	Suite of Documents relating to design works
SGN/PM/IGEM/1	Management Procedure for the application of IGEM Standards by SGN

SGN/PM/SHE/11	Management Procedure for Personal Protective Equipment and Workwear
SGN/WI/HAZ/1	Work Instruction for DSEAR Assessment of Meter Installations with Inlet Pressures not Exceeding 7 bar
SGN/SP/PA/9 and 10	Specification for painting structures in workshop and onsite
SGN/WI/WRAP/1	Work instruction for applying wrapped corrosion protection
SCO 1,2,4	Management of safe operations
DIS 4.1	Excavation and Reinstatement
SGN/PM/DIS/4.2	Management procedure for anchorage of systems operating up to 7 bar
SGN/W1/DIS/4.2.1	Work instruction for anchorage of systems up to 7 bar for Managers
SGN/W1/DIS/4.2.2	Work instruction for anchorage of systems up to 7 bar for Operatives
DN/SP/P/9	The welding of fittings to pipelines operating under pressure
GDN/PM/P/18	Management procedure for working on pipelines equal to or greater than 100mm nominal diameter containing defective girth welds or girth welds of unknown quality
DN/PM/Q/10	The Sampling and Testing of steel pipe and fittings used in Gas Pipeline

*New scope should be compliant with the requirements of BIO/2. Updating all existing hardware/software to BIO/2 spec will not be mandatory.

EICA Standards (General)	
BS EN 61511	Functional safety
BS EN 60079 Part 7	Electrical apparatus for explosive gas atmospheres
BS 6739	Code of practice for instrumentation in process control systems: installation design and practice
BS 7671	Electrical Wiring Regulations

These lists are not exhaustive, and competent Contractors are expected to be fully aware of the standards applicable given the scope of the Works.

5.3 Particular Civil Specification

The Contractor's attention is drawn to the standard details included on the civils drawings included with this concept design:

Civil Standard Detail Drawings	
BLD-GEN-DR-C-0001	Cable Draw Pit Installation Detail
BLD-GEN-DR-C-0002	Cable Ducting Installation Detail
BLD-GEN-DR-C-0003	Footpath Construction Detail
BLD-GEN-DR-C-0004	Pedestrian Gate Detail
BLD-GEN-DR-C-0005	ROV Kiosk Foundation Detail
BLD-GEN-DR-C-0006	Typical Fence Panel Detail
BLD-GEN-DR-C-0007	Valve Pit Arrangement
BLD-GEN-DR-C-0008	Network Main Probe Instrument Arrangement

Reference should also be made to any applicable standards listed in Section 5.2 and any other applicable standards. Designs shall be in accordance with these standards and the standard detail drawings. Deviations from these standard detail drawing arrangements and/or designs for elements not covered by these standard details shall be justified and approved accordingly.

5.4 Particular Mechanical Specification

For the mechanical elements of the Works, reference should again be made to any applicable standards listed in Section 5.2 and any other applicable standards.

Under-Pressure Connections

As is detailed in Section 3.2, it is proposed that the new instruments required at the RMP are installed on new fittings that are added to the network mains using under-pressure techniques. The technique employed shall be appropriate given the material, diameter and pressure class of the network main. All procedural requirements and associated documentation shall be observed and presented. Relevant information shall also be included at handover.

Valves & Fittings

The new valves and fittings required to achieve the new connections for RMP instruments and sample lines shall be fully compliant with the relevant GIS/SGN standards given the line size and pressure class concerned.

Welding (Including Electrofusion & Butt Welding of PE)

Where welding of metallic fittings and/or electrofusion/butt welding of PE fittings is proposed, all procedural requirements and associated documentation shall be observed and presented. Relevant information shall also be included at handover.

Coatings, Wrapping & Cathodic Protection

Where required, application and local repair of coatings shall be undertaken in accordance with relevant standards. Should the pipe material dictate, suitable wrapping should be allowed for. If the network main and/or the biomethane export main has a cathodic protection system, any modifications completed as part of the Works shall be compatible with said system and any remedial works on said system shall be included.

DFO (Propane System) Remedial Works

As noted in Section 3.2, it may be necessary to modify the propane control/dosing systems in the DFO GEU so that control of the propane dosing can be effective down to suitably low flow rates. During detailed design the Contractor shall engage with the DFO and/or GEU OEM to establish if remedial works are required. If remedial works are required, these shall be added to the scope for the Works.

5.5 Particular EICA/Control System Specification

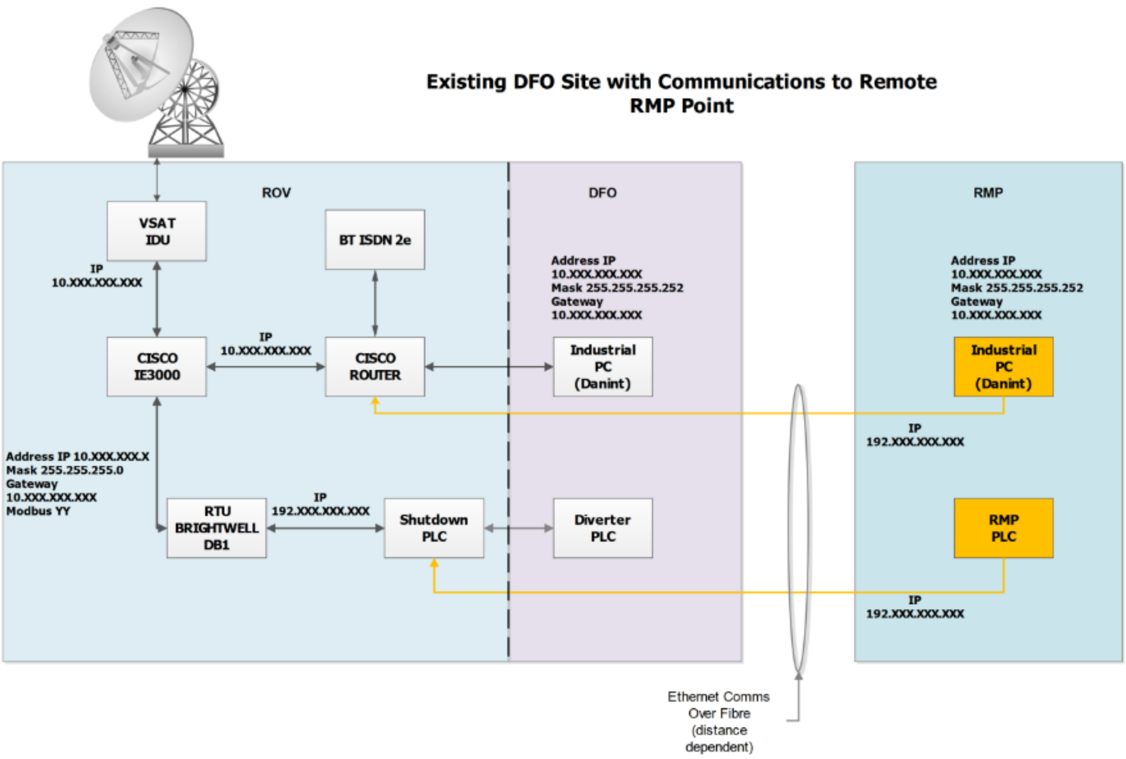
For the EICA/Control system scope included under the Works, reference should again be made to any applicable standards listed in Section 5.2 and any other applicable standards. In conjunction with the detailed design for the Works, the Contractor shall prepare a project FDS that describes the hardware/hardware interfaces and covers all control features and control modifications.

RMP Facility

As noted in Section 3.2 , the control panel in the RMP kiosk shall include an Industrial PC with HMI, a PLC, a UPS (with I/O) and communications modules (to facilitate the transfer of data between the RMP and the ROV). This PC shall supervise the CV DD and be running the Danint software to compile and share the necessary information regarding the Comingled CV. The PLC in this RMP panel shall be performing the calculation to generate the Offset and sending this Offset (along with all other data, I/O and alarms) back to the ROV for local utilisation or onward transmission to Gas Control via the existing telemetry system.

RMP to ROV Communications Link

Given the distances between the ROV and the RMP, and the options available based on the existing hardware in the ROV, the Contractor shall select a suitable communications protocol for this transfer. The figure below provides an indication of how the communications will likely be configured.



Again, as noted in Section 3.2 , this transfer may in fact be 'wireless point-to-point' in some cases. For this wireless point-to-point transfer, reliability and security shall be considered and the proposed solution submitted for approval. As indicated in Section 3.2 , a watchdog shall be included to monitor the status of this link and the health of the respective devices.

ROV Facility

As noted in Section 3.2 , the ROV RTU currently receives the Network Target CV from Gas Control. Software changes are required in the ROV RTU (and associated PLC) so that the Offset (received from the RMP) is applied to the Target and sent on to the DFO GEU. All of these changes and any hardware modifications shall be fully detailed in the project FDS (with associated I/O schedule). The ROV's fundamental functionality (as the last line of defence protecting the network from a GSMR perspective) will not change.

Modifications to Telemetry to Gas Control

The Contractor's FDS shall detail all additional data and alarms that will need to be added to the telemetry link with Gas Control. As a minimum, these shall include:

Additional Data & Signals on Telemetry to Gas Control	
Network Flow	Useful additional data.
Network CV	Useful additional data.
Comingled CV (from CV DD)	Includes Danint files.
Offset	Useful additional data.
System Alarm	To initiate an investigation. RMP point automatically goes to full propane, no blending
Intruder Alarm	Monitor security of RMP

If there are found to be constraints with the capacity of the ROV outstation, criticality shall be used to prioritise signals.

DFO Facility

Based on the concept solution described above, there should not be a need for EICA or control changes at the DFO. It may however be preferrable to include a representation of the prevailing conditions at the RMP and the current Offset. These modifications are not proposed as formal scope items under the Works.

6 Concluding Remarks

Comments and remarks are made in relation to the following.

6.1 Solution Optimisation Opportunities

Although the concept solution has been refined via productive (SGN/Supplier) stakeholder engagement, there are potentially further refinements and optimisation opportunities. Investigations into any further optimisation initiatives would be instructed and subsequently approved.

CV DD Instrument Selection

In order to save costs and reduce lead time, options for the type of CV DD instrument required/proposed could be considered in greater depth.

6.2 Stakeholder Engagement

Although both SGN and supply chain stakeholders have been engaged in the development of this concept solution, further engagement will clearly be required in order to progress the individual schemes. Identify the relevant stakeholders might be a useful enabling activity.

6.3 Proof of Concept

Depending on plan for roll-out, it may be prudent to deploy the concept solution at one of the nominated sites as a proof of concept. Selecting a suitable site should be possible with the information included in this study.