Project Code/Version Number:
FPLGDN01/1

1. Project Summary

1.1. Project Title	Tain Innovative Gas Grid
1.2. Project Explanation	This project will deliver Compressed Natural Gas (CNG) and biomethane via a new standalone network to the community of Tain in north-east Scotland. The project will benefit from a separate scheme to supply the nearby Glenmorangie Distillery, thereby allowing Tain customers access to the upstream infrastructure at marginal cost.
1.3. Funding licensee:	Fulcrum Pipelines Limited
1.4. Project description:	Problem: How to deliver a secure gas supply to a community that is too far from the integrated gas network for a conventional, physical connection to be economic. Methods: a) Utilisation of a twin-stream pressure reduction station (PRS) to take gas from 250 barg as CNG to domestic pressures – a first in GB b) A range of approaches for managing peak demand in a previously untried operational context - ensuring security of supply - and a trial of hybrid heating systems c) The use of a domestic regulator with a self-resetting low pressure cut-off mechanism, facilitating customer self-restoration in the unlikely event of a loss of supply d) Establishment of new regulatory and commercial arrangements for supplying CNG to a standalone network, not relying on ongoing subsidies from other gas consumers e) Development of new technical standards in relation to a) and c) Solution: A demonstration of how to develop a standalone gas network supplied by CNG without the need for ongoing subsidies, with the potential for roll-out to other towns in Scotland and more widely in GB. Benefits: Estimated financial benefits of £173.4m for roll-out at GB scale. Most households currently use electric heating - they will see estimated savings of around £800 p.a. The project will generate immediate environmental benefits by displacing fuels with higher carbon intensities. Further environmental benefits are achievable in the longer-term through the injection of H_2 into the gas mix and the use of heat pumps, with gas supplementing their output at peak times. GHG emission reductions are estimated at 466 thousand tCO_2e for GB roll-out scale. Network capacity of 2634 MWh/day would be created in a GB scale roll-out.

1.5. Funding			
1.5.1 NIC Funding Request (£k)	2139	1.5.2 Network Licensee Compulsory Contribution (£k)	240
1.5.3 Network Licensee Extra Contribution (£k)	360	1.5.4 External Funding – excluding from NICs (£k):	972
1.5.5. Total Project Costs (£k)	3728		

1.6. List of Project Partners, External Funders and Project Supporters (and value of contribution)	Project Partners CNG Services Limited Air Liquide UK Barrow Shipping Limited External Funders Highland Council Albyn Housing Society Cairn Housing Society } Levels of funding will be subject to internal approval nearer the time of network construction Project Supporters Highlands and Islands Enterprise The Glenmorangie Company iGas Energy Institution of Gas Engineers & Managers (IGEM) Scotia Gas Networks (SGN) Wales & West Utilities (WWU) Local Energy Scotland Home Energy Scotland

1.7 Timescale

1.7.1. Project Start Date	January 2018	1.7.2. Project End Date	September 2021

1.8. Project Manager Contact Details

1.8.1. Contact Name & Job Title	Carly Gilchrist Asset Director	1.8.2. Email & Telephone Number	carly.gilchrist@fulcrum.co.uk 01142 804240
1.8.3. Contact Address	Fulcrum Pipelines Limited 2 Europa View Sheffield Business Park Sheffield S9 1XH		

1.9: Cross Sector Projects (only complete this section if your project is a Cross Sector Project, i.e. involves both the Gas and Electricity NICs).

1.9.1. Funding requested the from the [Gas/Electricity] NIC (£k, please state which other competition)	N/A
1.9.2. Please confirm whether or not this [Gas/Electricity] NIC Project could proceed in the absence of funding being awarded for the other Project	N/A

1.10 Technology Readiness Level (TRL)

1.10.1. TRL at Project Start Date	7	1.10.2. TRL at Project End Date	9

Section 2: Project Description

2.1 Aims and objectives

The underlying Problem that this project is seeking to resolve is how to deliver a secure gas supply (with its associated environmental and financial benefits) to a community that is too far from the integrated gas network for a conventional, physical connection to be economic, with a view to exploring solutions that target the energy trilemma, focusing on heat.

The aim of the project is to demonstrate a Solution to this Problem by delivering a gas supply to Tain in north-east Scotland. Tain, a community of approximately 4,000 people, is roughly 13 miles from the integrated gas network. Up until now, homes, businesses and public buildings have been heated predominantly by electric storage heating and oil, with coal also present.

The project will benefit from a separate but closely-related scheme to supply CNG to the nearby Glenmorangie Distillery, displacing oil for its steam-raising process. The Glenmorangie scheme will provide the infrastructure to produce CNG and transport it by road to an installation near the distillery, allowing Tain customers access to the CNG supply chain at marginal cost. A connection to biomethane produced on the Glenmorangie site is also planned.

It was Glenmorangie who asked CNG Services and Fulcrum Pipelines to develop the Tain gas supply project. Their view was that the delivery of CNG to their distillery offers a great chance to alleviate fuel poverty in the nearby town and they wished to facilitate this; hence this Gas NIC bid. Fulcrum Pipelines and CNG Services aim to repeat this at other off-grid towns in Scotland [redacted]. The whisky industry is very important to Scotland and it must move away from oil by 2025 to comply with the EU Medium Combustion Plant Directive. This project should therefore be seen not just as facilitating carbon reductions and the alleviation of poverty in Tain, but as providing a blueprint for many similar projects in GB.

Glenmorangie is one of [redacted] distilleries expected to be supplied by road-delivered CNG from an NTS connection at Fordoun near Aberdeen. [redacted] Without this wider project, Tain and the other towns would not have an economic prospect of a move to CNG and biomethane. A further project is being developed to take CNG to Islay to supply 8 distilleries, which requires the regulatory changes to be in place from this project.

Through this NIC project, CNG and biomethane will be supplied into a new, standalone network constructed for the town. This gas will be considerably cheaper than electricity (presently used by a majority of Tain households) and competitive against heating oil, thereby delivering financial benefits to consumers and helping to alleviate fuel poverty. It will also be more environmentally-friendly, benefiting from the inclusion of compressed biomethane from Highland beef farms – which would otherwise not have a market. The project therefore facilitates delivery of the Carbon Plan through a reduction in carbon emissions. There is also the potential to use biomethane produced from waste products at the Glenmorangie distillery.

The project has a number of objectives reflecting the breadth of innovation across technical, operational and commercial/regulatory aspects of the scheme, and the scope for learning to support similar off-grid projects elsewhere in GB. Our approaches to these objectives, set out below, constitute the Methods being deployed to solve the Problem.

a) To demonstrate methods for supplying CNG and biomethane to a standalone network

The project will include a novel arrangement for the delivery of CNG to a domestic network – the first of its kind in GB - whilst meeting the requirements of the Gas Safety (Management) Regulations (GS(M)R). A twin-stream PRS will take gas from 250 barg as CNG down to distribution pressure for the Tain network.

The inclusion of a blending manifold with CV measurement enables the future injection of biomethane without the need to enrich the biomethane with propane.

The network will also be designed to accept hydrogen injection upstream of the blending manifold.

b) To develop and trial approaches to the management of peak demand in a previously untried operational context, thereby ensuring security of supply

Customers connected to the integrated gas network benefit from a national system operator balancing supply and demand on a daily basis, with access to a highly liquid gas market and a diverse set of entry points. For a standalone network, the challenge of maintaining a secure gas supply to a largely domestic customer base is quite different; supply-demand balancing has to be done locally without the benefit of a practically limitless supply of gas arriving through an upstream network.

Great Britain already has a small number of standalone networks in the form of the Statutory Independent Undertakings (SIUs), which are largely supplied by LNG (with some LPG). The SIUs depend on regular deliveries of LNG (or LPG) to maintain supplies, and therefore face a similar challenge. To help manage this, the SIUs have a certain amount of local storage available to them, equating typically to 8-9 days of peak gas demand, as shown in the following table, which was provided by SGN.

Table 2.1 – Data provided by SGN on demand and storage in the SIUs

	A	B	C	D	E
SIU	Annual demand (tonnes)	Total storage capacity (tonnes)	Daily peak demand (tonnes)	No of days storage based on average daily demands (A/365/B)	No of days storage based on peak day demands (B/C)
Campbeltown	2081	136.8	16.6	24	8.2
Oban	1987	128.6	13.9	23.6	9.3
Thurso	2890	176.1	21.7	22.2	8.1
Wick	2700	174.5	20.5	23.6	8.5
Stornoway	2863	540.0	19.5*	68.8	27.7

* Estimated

Rather than replicate this level of high cost storage, we are proposing a number of other approaches to ensure that we can maintain a secure supply of gas at all times:

- Enhancement of the CNG mother station at Fordoun through the addition of a standby diesel generator system to mitigate the risk of power supply failure;

- The ability to refill CNG trailers from the Leyland CNG filling station, as a back-up to Fordoun, to ensure supply continuity;

- The ability to use the phase 1 Glenmorangie PRS as a back-up for Tain, further enhanced by access to an emergency mobile PRS if needed;

- A plan to supplement the supply of CNG with biomethane from the Glenmorangie distillery anaerobic digester;

- The supply of CNG from the Lybster oil field around 50 miles to the north of Tain;

- The ability to interrupt the supply of CNG to Glenmorangie distillery (and potentially other large non-domestic customers) at peak times, providing access to up to two additional 10-tonne CNG trailers of gas;

- A permanent spare 7-tonne CNG trailer at Tain to provide approximately 8,600 standard m^3 (sm^3), of usable flexible storage, which together with the 10-tonne trailers could support forecast Tain demand for c. 4 days at peak periods[1];

- In the longer term, the ability to interrupt other distilleries in the Highlands, which will allow their CNG trailers to be used to supply Tain;

- Working with Registered Social Landlords (RSLs) and private home owners to facilitate and encourage improvements in insulation levels in order to manage down the level of gas demand;

- Installation of smart gas meters in every home on the network, which will allow us to build a better picture of domestic heating patterns and thereby identify peak supply risk and optimise supply logistics.

In addition, we plan to trial the use of hybrid heating systems (comprising an air-source heat pump and a gas boiler) in 45 residences (using three different configurations) to investigate the extent to which the heat pump can contribute in cold conditions. While we are not relying on this as a mechanism for reducing demand in this project, we hope that the trial will demonstrate a potential method for future projects of this sort and provide general information on the co-management of smart heating systems which use two energy vectors. The hybrid heating system combination is increasingly seen as one that may form a large part of the solution for decarbonisation of space and hot water heating.

c) To use low pressure cut-off (LPCO) devices, which would support an innovative network restoration process

The project will be carefully designed to meet supply security standards, and will benefit from the ability to interrupt the gas supply to the Glenmorangie distillery. Nevertheless,

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[1] Assumes high case take-up, but initial phase of customer conversions

in the absence of an integrated network upstream or high levels of storage, it is prudent to build in an additional level of safety and security. We are therefore planning to use the combined regulator/LPCO device described in Section 2.2. This device, which has not previously been used within GB, allows the system to fail to safety rather than failing to danger in the event of a loss of gas supply, and would facilitate bringing the network back on line quickly with customer self-restoration, as explained further in Section 4 (d).

d) To develop associated technical standards

As part of this NIC submission, we are requesting a modest level of funding to support the development of industry technical standards in relation to the 250 barg PRS and the combined regulator/LPCO. These new standards, whose development will be managed by IGEM, will support the future roll-out of similar standalone networks.

e) To establish regulatory and commercial arrangements for the supply of CNG to a standalone network that do not rely on ongoing subsidies from other gas consumers

The operation of the SIUs relies on ongoing subsidies from GB gas consumers, levied through NTS charges. We believe that it is unrealistic to expect future standalone networks to be funded in this way, and that it is in the interest of all parties to establish a regulatory approach that facilitates the development of such networks on a fully commercial basis. There are a number of issues to be overcome and we are seeking NIC funding in order to facilitate these changes, thereby allowing the CNG option to be used further afield in Scotland and elsewhere in GB. Section 7 covers these issues in greater detail.

2.2 Technical description of Project

Overview of the Glenmorangie scheme – a pre-requisite for this project

This project depends on, and benefits from, two key schemes.

Conversion of Glenmorangie to CNG

Glenmorangie Distillery currently uses fuel oil for steam-raising. However, the EU Medium Combustion Plant Directive requires oil to be replaced by 2025, which has led to the project to convert the distillery to natural gas, with dual-fuel boilers.

Gas will be supplied to the distillery via a 'virtual pipeline,' an innovative solution that uses CNG trailers to transport gas by land where no pipeline is available. The initial sources of gas will be the NTS at Fordoun and the Lybster oil field.

The CNG 'daughter station', at which the trailers are off-loaded, is to be built 450m from Glenmorangie Distillery, approximately 700m to the north-west extremity of Tain.

Fordoun mother station

The main source of gas initially will be a mother station at Fordoun, which will produce CNG from gas taken from the National Transmission System (NTS). This mother station is being developed by CNG Services and Air Liquide UK to provide CNG for a number of Highlands distilleries including Glenmorangie.

Appendix E contains a map of the area showing the CNG transport route between Fordoun and Tain.

CNG daughter station at Glenmorangie

The development of the daughter station at Glenmorangie has been divided into three phases. Further technical details of the daughter station are contained in Appendix E, together with an indicative draft layout in Figure E1 and a map showing its location in relation to Tain in Figure E3.

Phase 1 – supply of CNG to the distillery

Phase 1 includes the construction of the Glenmorangie daughter station and any equipment necessary to supply the nearby Glenmorangie distillery. The main items of equipment under phase 1 are three trailer bays, three offloading cabinets, a single-stream 250 barg to 7 barg PRS and downstream single-stream 7 barg to 2 barg PRS with a flow meter (all located in the daughter station compound), with a 490m medium pressure pipeline and final regulator to boiler pressure at Glenmorangie distillery. Phase 1 will operate using three 7-tonne CNG trailers.

The maximum flowrate of gas to the distillery will be approximately [redacted]. An electrical/telemetry kiosk will satisfy the electrical and control requirements of the site.

This phase is out of scope of this NIC project, but a pre-requisite for it.

Phase 2 – supply of CNG to Tain

In Phase 2, equipment required to supply gas to Tain will be added to the daughter station, principally a twin-stream 250 barg to 7 barg PRS, a calorimeter and a downstream twin-stream 7 barg to 75 mbarg regulator with a flow meter. A diesel generator and an uninterruptible power supply (UPS) will also be required to ensure a secure electricity supply to the site. A short length of 7 barg intermediate pressure pipe will transport gas from the PRS to the meter. The section headed 'Tain PRS' below contains further details of the PRS.

Hazardous Substances Consent (HSC) will be sought during phase 2 for the area where the daughter station is to be built. Under current regulations, a maximum of 15 tonnes of gas is permitted onsite without HSC. Obtaining HSC will allow the use of larger trailers, simplifying logistics and increasing supply in the case of emergency. COMAH will not need to be considered for the site as there will not be over 50 tonnes of natural gas present onsite at any one time.

NIC funding is sought for investments made under this phase, although excluded from the NIC funding request is the possible replacement of the 7-tonne trailers with 10-tonne trailers. We plan to phase the 7-tonne trailers into the other distillery projects across Scotland whilst new trailers are purchased for use in this project.

Phase 3 – biomethane from the distillery anaerobic digester

In Phase 3, infrastructure required to supply biomethane from the distillery anaerobic digester will be constructed, principally a biogas-biomethane upgrader, a grid entry unit and the pipework required to connect the biomethane into the blending manifold. The plan is for biogas production to be expanded, and for the biomethane to become part of the comingled stream of gas, together with the CNG, which will supply the town and the distillery.

This phase of work has been excluded from the scope of the NIC project, although the implications of the biomethane supply for the delivered gas price and environmental benefits have been taken into account.

Tain PRS

As described under 'phase 2' above, a PRS will be installed, which will be dedicated to the supply of gas to Tain. As security of supply to Tain is of utmost importance, this PRS will be twin-stream, with full redundancy. This PRS will be linked in parallel with the distillery PRS installed under phase 1.

The PRS will have a maximum flowrate of 1,000 sm^3/hr, with an inlet pressure of 250 barg and an outlet pressure of 7 barg. Trailers will be emptied individually, each through a separate offloading cabinet using an included flexible hose, until they reach a pressure of around 20 barg. At this point, a control cable between the PRSs and cabinets will switch supply over to the next available trailer and cabinet. Section 4 discusses the plan to develop an IGEM technical standard to cover this PRS, which will be the first in GB to reduce pressure from 250 barg for supply to a domestic network.

Gas from the two PRSs (with biomethane from the distillery anaerobic digester following phase 3) will be mixed at 7 barg in a blending manifold before the calorific value (CV) is measured by a calorimeter for billing purposes.[2] The gas flow will then split, flowing to the distillery using phase 1 infrastructure, and to the Tain gas network via the phase 2 7 barg-75 mbarg twin-stream meter module.

As is the case at Fordoun, a diesel generator and UPS will be installed to mitigate the risk of an electrical supply interruption.

Tain distribution network

We plan to develop the Tain distribution network in phases. The initial phase – the subject of this NIC funding submission – will comprise a feeder main from the daughter station in the grass verge by the side of the A9 and into Tain along the B9174 to the far side of the town, together with mains along the streets in which social housing is most prevalent on the south-east side of the town. In total, we anticipate the installation of approximately 6.4 km of mains in this initial phase. Appendix E contains a map showing an indicative layout for these mains.

Since we are targeting the area in which social housing is concentrated, we are confident that commitment to the project from Highland Council and Albyn Housing Society would lead to a very high customer conversion rate. We also expect that some private houses along this route will wish to connect, as well as a few non-domestic customers. This approach therefore allows us to plan the initial development of the Tain network with the greatest possible degree of confidence.

With this infrastructure in place, future phases – outside the scope of this NIC submission – will be undertaken on a commercial basis provided that there is a sufficiently high take-up rate.

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[2] We anticipate Ofgem approval of the Orbital PT calorimeter in Q4 2017 but if approval is not gained, it will be necessary to purchase a full gas chromatograph system.

Medium Density Polyethylene (MDPE) pipe of various standard diameters from 315 mm to 63 mm will be used. The network will operate at a gas pressure of between 75 and 21 mbarg, suitable for supply to domestic and I&C customers, enabling their gas appliances to work safely and efficiently.

Gas services will also be constructed using MDPE, with all domestic services at a standard diameter of 32mm, ensuring that the pressure at the emergency control valve (ECV) does not fall below the statutory minimum requirement of 19 mbarg for a network of this type. Each service will be tailored to the requirements of the individual customer in respect of the service and gas meter termination point.

Low Pressure Cut-Off (LPCO) device

As we explained in Section 2.1 (c), we plan to incorporate an LPCO within every customer's gas meter installation.

In domestic properties, this would be in place of the industry standard IGEM PRS3 specification domestic low-pressure meter governor/regulator. The domestic combined regulatory/LPCO has an external appearance, dimensions and pressure regulation functionality identical to the PRS3 regulator. However, it has the added function of cutting off the supply of gas to the household internal gas pipework and appliances, giving increased safety, if and when the pressure in the household pipework falls below 12.5 mbarg, such as any occasion on which gas is interrupted.

The device has a built-in self-reset, which allows it to re-open when pressure is restored, provided no pre-'Gas Appliances Directive' (1993) downstream appliances are on the network and have been left switched on. Modern GAD-specification gas appliances have built in safety devices which shut off burners if the flame is extinguished. There will be no additional charge to the domestic consumer for this device.

The combined regulator/LPCO device has not been used before in GB, and there is no IGEM standard for it. It has however been demonstrated successfully in the Isle of Man. Initial discussions with IGEM have identified that PRS3 covers many of the aspects of the device, including regulation function and materials, but does not cover the LPCO function; accordingly, it has been proposed that a revised version of PRS3 be produced to cover this device. Costs and timescales are included in the budget and programme.

Each non-domestic meter installation would also incorporate a separate standalone LPCO, which would differ slightly from those in domestic premises by having a manual, customer-operable, reset.

As a direct consequence of every customer connected to the network having an LPCO, and subject to HSE approval, Fulcrum Pipelines will be able to change the way it restores gas supplies after any interruption, as described in Section 4.

Peak demand management solutions

As outlined above, we have identified a broad range of measures to ensure security of supply for Tain gas consumers. The more technical of these measures are explained here.

In order to inform the necessary range of measures, supply logistics have been modelled, taking account of trailer journey, connection, waiting, filling and unloading times. A wide variety of scenarios have been explored, but with a particular focus on meeting peak demands from Tain under the high customer take-up case. The model is explained in Appendix F.

Standby diesel genset and uninterruptible power supply at Fordoun

The need for a 500kVA diesel generator and a smaller uninterruptible power supply (UPS) were identified as part of a risk assessment relating to the supply of domestic consumers. The generator will ensure the station's operation in the case of an electricity supply interruption, increasing the security of CNG supply and alleviating the identified risk, whilst the UPS will ensure a smooth switch of electricity supply from grid electricity to the diesel generator in such an event.

These are the only capital costs at Fordoun for which NIC funding is sought.

Access to Glenmorangie PRS and emergency PRS

As explained earlier, the Tain PRS will be twin-stream as opposed to single-stream, providing in-built redundancy. Nonetheless, to give further resilience, should this PRS fail totally, the distillery PRS would be used to supply the town, with the distillery's gas supply interrupted if required. In addition, CNG Services has access to a mobile PRS, which, in an emergency, could travel to Tain to perform a similar function to the installed PRSs.

Use of Leyland CNG filling station as back-up

Leyland is an operational CNG filling station where gas is taken from the nearby Local Transmission System (LTS) and compressed. The station is owned and run by CNG Fuels and currently provides CNG as a vehicle fuel for HGVs. Leyland will operate as an emergency back-up filling station for Tain in the event that CNG from the other gas sources becomes unavailable. Although this would involve longer trailer travel times, analysis shows that it would still be possible for three CNG trailers, each transporting 10 tonnes of gas, to satisfy the planned level of peak demand in the town with the distillery supply interrupted.

Spare trailers

A trailer logistics schedule has been modelled based on assumptions of gas demand, journey times and the unloading procedure. This schedule can be amended at times of high demand in order to transport gas more regularly to the daughter station.

Although 7-tonne trailers will be used to supply the distillery in phase 1, these will be replaced by three 10 tonne trailers which will be used to supply gas to Tain. Each trailer is able to transport 13,360m^3 of natural gas. An inability to fully unload and a small parasitic gas load from the PRS to fuel the boiler, however, means that a usable amount of approximately 12,496m^3 will be transported per trailer.

In addition, and to mitigate any upstream supply failure, it is planned to have a CNG trailer with a 7-tonne capacity parked onsite near the daughter station. The storage provided by this trailer would give additional time for any upstream problems to be resolved in the unlikely case of a failure of supply.

Smart metering solution

Domestic premises

Every house connected to the network will have an industry standard smart gas meter installed. Where a smart electricity meter is already in place, the gas meter will interface with and use the existing communication hub and display. However, where the gas meter is the first smart device in the house, an industry standard communication hub and display will be installed, compatible with any future smart electricity meter. Whilst the smart gas meter is not in itself innovative, it facilitates the innovation described in Section 4 d).

Non-Domestic premises

The smaller non-domestic premises connected to the network will have the same smart meter installations as domestic properties. However, as there is no smart meter for gas loads greater than $6m^3$/hr, any such non-domestic premises would have meter installations incorporating standard 'non-smart' meters. To enable the data innovation described in Section 4, these would be fitted with industry standard Automatic Meter Reading (AMR) dataloggers.

2.3 Description of design of trials

Hybrid heating systems

One of the project's innovations involves a trial of the operation of hybrid heating systems. These comprise an air source heat pump (most likely at 8kW heat output rating) and a gas boiler (most likely at 33kW capacity). The primary objective of the trial will be to investigate the potential for the air source heat pumps to contribute to the mitigation of peak demand, and hence to reduce the need for CNG deliveries during periods of high demand and/or for additional storage of CNG. Consistent with this, the trial will explore:

- Three different hybrid heating system configurations (monovalent, bivalent parallel, bivalent series) to identify the advantages of each, particularly in respect of the primary objective;
- Strategies for cost and carbon reduction with an emphasis on standalone networks in regions currently served by other means;
- Smart strategies where interactions between the two vectors are managed synergistically with the primary objective in mind.

In addition to the direct advantages to the Tain network operator and consumers of the hybrid heating trial, the systems will provide very useful information for future deployment in similar networks across GB. There is increasing recognition that (a) domestic heating will be difficult to decarbonise and (b) that purely electric systems will suffer from the need for high levels of infrastructure to manage peaks. The hybrid hardware configuration is seen as one of the likely strategies for meeting future heating needs while dealing with all aspects of the trilemma.

Our trial's design is based on 45 residences. This number is based on 15 residences per hybrid configuration to provide statistical significance accounting for diversity in (i) building size; (ii) building thermal properties, and (iii) occupant type and behaviour (see Appendix G for further details). The trial will use a 'design of experiments' method (see also Appendix G) to ensure maximum information is gained for each hybrid heating configuration, and to be able to make comparisons between configurations.

2.4 Changes since Initial Screening Process (ISP)

The definition of the project has developed in many respects since the ISP, the more significant changes being:

- The de-scoping of customer central heating conversions from the project definition, other than in respect of the hybrid heating systems, the incremental cost of which is sought through the NIC. The only impact of this change is a reduction in the stated total project cost;
- Revised project timescales, primarily to allow a longer period for framework development, customer acquisition and detailed planning through the course of 2018;
- Greater clarity of which peak demand management strategies will be adopted, as set out earlier in this section;
- The inclusion of hybrid heating systems on a trial basis to provide applicable learning to support the development of future standalone networks;
- A reduction in the level of NIC funding sought from £2.370m to £2.139m;
- Clarification of the Project Partners, including the decision not to include a gas supplier as a partner at this stage, pending a competitive selection process in 2018.

Section 3: Project business case

3.1 Summary

The Tain Innovative Gas Grid project seeks to demonstrate that gas can be delivered to consumers economically through a standalone distribution network. It is doing so in a part of the country where fuel poverty is high, and consumers will see immediate financial benefits as a result of their connection to gas.

In order to achieve this, we have had to apply fresh thinking to the challenge of maintaining a secure gas supply to a largely domestic customer base. We cannot rely on a practically limitless supply of gas being available via an integrated network, and it would be uneconomic to build many days' worth of local storage – the approach utilised by the SIUs. The Methods employed for Tain will be a combination of logistical, commercial and technical approaches, applying a range of technologies for the first time in this operational environment.

The project will generate immediate environmental benefits since the gas supplied will have a lower carbon intensity than any of the fuels used to heat properties in Tain at present. The presence of a gas supply will facilitate further environmental benefits in the short-term through ongoing customer conversions. In the long term, further benefits will arise through the potential injection of hydrogen into the gas mix and the increased penetration of heat pumps, with gas available to supplement their output at peak times via hybrid heating systems of the type to be trialled in Tain. More broadly, by trialling hybrid heat pumps in a variety of modes, this project will provide transferable learning on how to design, install and operate a flexible, multi-vector heat supply system.

In order to deliver the Tain Innovative Gas Grid, a number of new approaches, technical standards and frameworks must be developed, reflecting the breadth of innovation that underpins this project. Once established, they will be available for the benefit of future standalone gas network developments, regardless of which gas transporter takes them forward.

CNG Services and Air Liquide UK are developing a CNG mother station at Fordoun near Aberdeen that will utilise gas from the NTS via a connection to an NTS Block valve. [redacted] Whilst no gas industry innovation funding is being provided for that project it is highly innovative and facilitates this NIC project. National Grid Transmission have agreed that this can be a pilot NTS self-lay connection, which offers a significant cost reduction. There are significant savings in capex and opex from using 65 barg gas to make CNG. [redacted]

Fulcrum Pipelines plans to play a major role in the implementation of future standalone networks. Of immediate interest are the off-grid Scottish towns near to other distilleries including ones close to the initial batch of [redacted] distillery projects. Beyond that, the aim is to take gas to Islay to supply 8 distilleries and build a network to supply domestic customers based on the Tain model, with CNG blended with biomethane made on Islay and the potential for hydrogen blending. The successful demonstration of the concept at Tain (including the establishment of a suitable regulatory framework) is critical in order to unlock the investment that will support the Islay project and other similar developments. CNG Services and Barrow Shipping have had a number of meetings with Ofgem to discuss regulatory issues associated with Islay. These identified fundamental issues which are addressed in the Tain project. Around 20 further off-grid Scottish towns could benefit from the Tain model and there are similar towns elsewhere in the country, particularly in the South West of England and East Anglia, and potentially also in Wales.

As each standalone network is developed, the unit cost of the upstream CNG infrastructure will fall as a result of scale economies, and the logistics of delivering gas to the towns will benefit from a greater level of flexibility. This use of CNG is also complementary to the development of CNG stations to fuel trucks, which is driving the development of further CNG stations (e.g. Leyland CNG station developed with partial NIA funding from Cadent, and Milton Keynes CNG station which has received support from Innovate UK).

We have received a very high level of interest in this project from potential stakeholders and partners. They see the immediate potential to provide financial benefits to the residents of Tain, and they also see the broader potential for the concept – a new way of delivering the benefits of gas to off-grid communities, thereby improving lives and supporting delivery of a lower carbon future. Appendix N contains the letters of support that we have received.

The multi-faceted nature of this project creates risk for those investing resources into it and without NIC funding it would not be feasible. Innovation funding will reduce the level of risk and fund the development of new approaches, standards, frameworks and trials; one-off costs which will generate learning for, and reduce the cost of, similar projects in future. These projects include smart, multi-vector heating systems not necessarily in areas with existing gas networks, providing learning on the potential role of existing GDNs in a low carbon future. Financial backing from Ofgem will give confidence to other project stakeholders and supporters to invest their time, and may also help with the acquisition of customers. And once this project has been delivered, we expect that its success will be a key lever when seeking sources of external funding to support future projects.

3.2 Alleviation of fuel poverty

Tain is situated on the Dornoch Firth, approximately 30 miles north of Inverness in Highland, northern Scotland. Whilst the main local industry is agriculture, with some employment in tourism and associated service industries, the Glenmorangie distillery on the outskirts of the Town is an important local employer and a key part of the economy. Data provided by Highland Council indicates that 59% of households in Tain live in fuel poverty.

In Section 4 we present analysis of the financial benefits of the project. We demonstrate that this project is significantly more economic than the most efficient method currently in use on the GB gas transportation network – supply by LNG, deploying the approach used for the SIUs. The calculation summarised there, and shown in detail in Appendix B, identifies financial benefits of £10.8m (project scale, central case) and £173.4m for roll-out at GB scale. In reality, however, given the cost of connection, it is unlikely that Tain would ever have a gas supply unless it is delivered by CNG. We have also, therefore, examined the financial case from the perspective of savings to Tain consumers.

In summary, we estimate that a typical household currently using electric storage heating will save over £800 per annum if they convert to gas. Highland Council data suggests that 73% of those in social housing in Tain (the primary focus of our initial development plans) use electricity for heating. The current low oil price is very similar to our target delivered gas price, however oil users who convert to gas will also benefit from a significantly lower price risk since (unlike oil) the bulk of the Tain gas price is independent of the wholesale price. There are also still some householders using coal or other solid fuels, who will benefit from gas in terms of quality of life, with air quality benefits to the town.

3.3 Delivering environmental benefits and accelerating the development of a low carbon energy sector

The conversion to gas in Tain will carry immediate environmental benefits as a result of its relatively low carbon intensity compared with the alternatives currently deployed. Further benefits will accrue in relation to air quality by replacement of fuel oil and solid fuels. Indeed, every opportunity is being taken to maximise the level of environmental benefits, both on the supply-side and on the demand-side. These opportunities support and accelerate the development of a low carbon energy sector and contribute to the delivery of the heat decarbonisation and energy efficiency aspects of the Carbon Plan.

In relation to supply, as far as possible, biomethane will be incorporated into the gas mix, sourced from Highland beef farms and from the local distillery anaerobic digester. We are aiming for 30-35% of the gas delivered through Tain’s domestic network to come from these sources from 2020 onwards.

In the longer term, we see the potential for hydrogen to become part of the mix. Building a new distribution network entirely from polyethylene pipe provides an opportunity to introduce hydrogen at a later date more simply than would be the case in a network that still has iron mains. Cadent’s HyDeploy NIC project is using Keele University's private network to demonstrate that natural gas containing levels of hydrogen up to 20% can be distributed and utilised safely. We are liaising with the Cadent HyDeploy NIC project to ensure that we incorporate any relevant learning into this project. In addition, ENGIE is conducting experiments alongside the Dunkerque Urban Community to inject hydrogen into the natural gas supply networks of a new residential neighbourhood[3]. Their early results have revealed no material issues.

We have therefore assumed that 20% hydrogen in the gas mix may be achievable towards the end of the period to 2050 at Tain.

Our initial thinking is to utilise hydrogen produced locally using electricity at times of low electricity cost, together with a small hydrogen storage facility. Whilst electrolysers at present are expensive we expect lower cost devices from the mid 2020’s which will coincide with longer periods of low electricity prices. We are also assuming that there will be no environmental levies on such electricity to allow its utilisation in hydrogen production and in battery storage (as we believe indicated by BEIS). We have started a dialogue with SSE in relation to distribution network capacity to use electricity to generate hydrogen.

On the demand-side, Highland Council and the two housing associations have EESSH obligations[4] to ensure that all of their houses meet minimum standards of insulation by 2020. We will also do whatever we can to encourage private house-owners to do the same prior to their connection to the gas network. Our gas demand analysis therefore incorporates an assumption of a 25% average reduction in heating requirement across all houses that convert to gas. This corresponds to an SAP rating improvement of around 15-20 points, which we believe is achievable based on levels of demand reduction achieved with insulation improvements during a National Energy Action (NEA) trial in Worksop[5]. During the development of this project, we have considered whether it would be feasible to mandate a minimum level of insulation as a pre-requisite for a new gas connection in the same way that BEIS require for domestic RHI payments. This is something we plan to discuss further with Highland Council, and we believe this would be a valuable innovation if adopted across GB.

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[3] http://www.engie.com/en/innovation-energy-transition/digital-control-energy-efficiency/power-to-gas/the-grhyd-demonstration-project/

[4] http://www.gov.scot/Publications/2014/03/3154/4

[5] http://www.nea.org.uk/wp-content/uploads/2015/07/Monitoring-air-souce-heat-pumps-in-domestic-properties.pdf

In summary, we estimate that this project will result in cumulative greenhouse gas emission reductions of approximately 35.7 thousand tCO_2e to 2050 (central case). A roll-out of standalone networks to 20 further towns has the potential for cumulative greenhouse gas emission reductions of approximately 466.0 thousand tCO_2e to 2050 (also central case).

There is increasing emphasis amongst policy-makers and in the energy industry on strategies to decarbonise heat, especially for residential consumers. Through the development of a standalone gas grid, future energy provision to Tain could involve any (or all) of the primary routes to heat decarbonisation currently under discussion: greater use of biogases; use of hydrogen (as part of the gas mix or through a full conversion); electrification, with access to gas to top-up heat provided by heat pumps when necessary; and/or potentially the development of a CHP/district heating system based around the new community campus.

In relation to the latter approach, hybrid heating systems that use electricity and gas in a synergistic fashion have the advantages of (a) providing much greater flexibility in system operation and mitigating peaks across both vectors, (b) reducing the size of heat pumps required, and; (c) providing an opportunity for green gas to be used in domestic heating. A great deal of analysis has been undertaken on these topics but demonstration projects for learning are lacking.

We are therefore proposing to use the Tain development as a test-bed for a trial of hybrid heating systems as a mechanism for reducing gas demand at peak times. The potential for gas boilers to top-up energy from heat pumps at peak times is under active investigation by policy-makers considering the future of heat. Related to this, WWU and WPD's ongoing FREEDOM NIA project (installing 75 hybrid heating systems in Bridgend) is investigating the potential use of such systems. Our proposed trial will complement this by exploring the potential for heat pumps to contribute at times of high demand, thereby reducing strain on CNG deliveries and stocks. By incorporating this trial into the development of a standalone gas grid, we will create transferable learning on how to design, install and operate a flexible, multi-vector heat supply system.

3.4 Potential for future roll-out

As noted above, there are a number of other towns in Scotland with nearby distilleries, each of which could benefit from the roll-out of a standalone gas network similar to the one we are proposing for Tain. Islay is the next main target given that it has 8 distilleries and also exports significant distillery waste, or disposes of this at sea. Having a network on Islay to connect the distilleries and domestic customers, and to facilitate the supply of low carbon energy in the form of biomethane and hydrogen, is an important roll-out opportunity, which the Tain project would support. Other targets on the mainland include [redacted], which range in size from around 1,300 residents to over 10,000, although their mean population is similar to that of Tain.[6]

We would expect the cost of a standalone CNG network to be lower for subsequent distillery towns having undertaken this project. There are a number of reasons for this:

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[6] Based on 2011 census data

- The Tain project will incur a number of one-off costs for: the addition of a standby diesel generator and uninterrupted power supply to strengthen the CNG production process at Fordoun; the development of technical standards and safety case changes; the establishment of necessary regulatory and commercial frameworks, the trial of hybrid heating, and; the development of data management systems. These one-off costs amount to around [redacted];
- When we supply another distillery town we will be able to realise additional efficiency savings at the daughter station of around [redacted], utilising an integrated design, which will include sharing a twin-stream PRS with the distillery;
- The experience gained from Tain will lead to further cost reductions related, for example, to design, project management and peak demand modelling activities, with data and analyses readily transferable;
- Unit costs of delivering CNG by road will fall (potentially by around 20%) with economies of scale both in the production of CNG at the Fordoun Mother Station, through more efficient utilisation of drivers and tractors, and the development of more efficient CNG equipment as technology develops;
- Once the [redacted] distilleries supplied from Fordoun are fully on CNG there will be a CNG supply chain that will make additional projects easier to supply, with maintenance staff working full-time on the CNG project and a diversity of trailers and interruptible loads;
- Other learning from this project will be valuable for the optimisation of future projects, including learning associated with the assessment of customer take-up rates and demand forecasting that takes advantage of sub-daily readings from gas smart meters.

The net impact of these savings is an estimated reduction in costs for a future standalone network at one of the distillery towns equivalent to [redacted]/kWh compared with the total cost of this project (or approximately [redacted]/kWh lower than the price implied by Method costs). This results in a delivered gas price of around 5.3p/kWh even assuming no additional external funding can be obtained. We therefore believe that it will be possible to deliver such a network without further funding from the NIC. Appendix B sets out the calculation underpinning this conclusion.

However, we believe that the successful delivery of the Tain gas network will help us to access other sources of external funding to support future developments. This will be particularly important when rolling out the concept to towns without a local distillery (or similar large load), for which the reduction in economies of scope and scale will put upward pressure on costs (see also Appendix B). By way of example, the Public Works Loan Board (PWLB) can provide loan funding for local authorities to carry out capital infrastructure projects and the Communities and Renewables Energy Scheme (CARES) provides grant funding and loans to support projects that link local energy generation with local energy use. These schemes are summarised in Appendix L together with the numerous other schemes available in Scotland to householders and businesses to support energy efficiency measures, gas connections and associated heating system replacements.

3.5 Impact on Fulcrum Pipeline's business

In the last two years, Fulcrum Pipelines has been successful in building a number of new gas networks to connect distilleries in Scotland, with projects delivered on time and on budget. As a result we have good relationships with the distillery owners. Whilst a connection to the national pipeline system is normally the best option, this is generally not a feasible option for remote Scottish towns. We are therefore pleased to be working with CNG Services and Air Liquide UK to provide the licensed GT network for projects such as Tain.

Fulcrum Pipelines has all the necessary competencies and processes and we see this as a development of our existing business that is primarily focused on providing integrated gas networks for new gas consumers. The learning from multi-vector approaches on the Tain project is something that we also aim to apply in our wider business.

Section 4: Benefits, timeliness, and partners

(a) Accelerates the development of a low carbon energy sector and/or delivers environmental benefits whilst having the potential to deliver net financial benefits to future and/or existing Customers

Section 3 set out the overarching business case for this project. Here we analyse in more detail the environmental benefits arising from the construction of a standalone gas network in Tain itself, and the financial benefits that will accrue. We also present analysis of the additional gas network capacity that is created through the development of a 'virtual pipeline' in the form of the CNG supply chain, and we show how the proposed Solution offers value to consumers in comparison with the most efficient solution currently in use on the GB transportation system. The analysis of environmental, network capacity and financial benefits is then extended to illustrate the potential benefits that could be achieved from a broader roll-out of standalone gas networks such as the one proposed for Tain.

Delivery of Environmental Benefits

Gas sources for Tain

The following gas supply sources are planned:

- Fordoun: Natural gas from a new NTS offtake at Fordoun. Odour will be added and CNG produced immediately downstream of the NTS offtake at a CNG mother station, which is being developed by CNG Services and Air Liquide UK*.* This is due to be complete by Q1 2018. The CNG will then be transported by road to the CNG unloading site (daughter station) adjacent to the Glenmorangie Distillery.

- Lybster: This gas is a by-product of the oil production process, and would otherwise be flared. Odour will be added to the CNG and it will be transported by road to the unloading site. Since the oil field is not currently producing, we cannot claim that flaring is being avoided and hence we have not assumed an environmental benefit compared with natural gas generally.

- Beef biomethane: Biogas will be produced from slurry at Highlands beef farms, upgraded, odorised, compressed and transported to the unloading site as compressed biomethane. The creation of a market unlocks the opportunity to produce biomethane at these remote sites.

- Glenmorangie biomethane: The distillery has recently commissioned a new anaerobic digester, which creates biogas from the distillery's waste water. There is potential to expand this facility and upgrade the biogas to biomethane so that it can be odorised and mixed with gas from the other supply sources at the unloading site. We anticipate that this development will happen shortly after the other supply sources are on-stream and after the main construction activity at Tain has taken place. We therefore propose to exclude this from the scope of the NIC project, although it remains relevant from a supply security and environmental benefits perspective.

Potential for hydrogen blending

The opportunity to design and build the Tain network from scratch will facilitate hydrogen blending at a later date. While this is inevitably uncertain at this stage, we are assuming that hydrogen will form part of the gas mix at Tain from the late 2030s.

Potential for shale gas

Although this is not factored into our assumed gas supply profile, if shale gas is produced in Scotland, standalone networks could potentially provide a market for the gas utilising the CNG trailers.

Assumed gas supply profile to 2050

The profile of gas supply sources for Tain will vary over time. Gas from Lybster and compressed biomethane will dominate the mix in the medium term, with hydrogen forming a greater part of the blend in the longer term. Our analysis is based on the assumed profile shown in Table 4.1.

Table 4.1 – Assumed gas supply profile for Tain

Gas source	2020	2030	2040	2050
NTS Fordoun	10%	40%	45%	45%
Lybster	60%	25%	0%	0%
Beef biomethane	15%	20%	20%	20%
Glenmorangie biomethane	15%	15%	15%	15%
Hydrogen	0%	0%	20%	20%

Environmental benefits compared with alternative fuels

Tain consumers predominantly use electric storage or oil heating at present. Conversion to natural gas will therefore immediately result in reduced greenhouse gas emissions. However, this benefit will be significantly enhanced since the gas supply profile for Tain will result in materially lower carbon emissions than if it was all natural gas from the integrated GB network. Weighted average emissions consistent with the assumed supply profile will gradually reduce from 171 gCO_2e/kWh in 2020 to 120 gCO_2e/kWh in 2050.

Furthermore, those consumers who choose to install a hybrid heat pump will see an additional benefit arising from the greater efficiency of their heating system. Table 4.2 shows the forecast emission reductions arising from this project through the conversion of consumers' heating systems. Appendix D sets out this calculation in more detail.

Table 4.2 – Projected emission reductions from Tain project

Case	Cumulative savings Thousand tCO$_2$e		
	2030	2040	2050
Tain – high	12.4	27.1	43.5
Tain – central	10.3	22.2	35.7
Tain – low	6.0	12.9	20.8

Potential for broader roll-out

We have identified 5 similar Scottish towns with distilleries that could convert to CNG [redacted], a further 20 off-grid Scottish towns without distilleries that would benefit from a standalone CNG-supplied network and a number of similar towns in East Anglia and the South West of England.

Table 4.3 shows projected cumulative emission reductions (central cases only) assuming the same approach to the development of a standalone network was rolled out at the 5 distillery towns and 5 further non-distillery towns in Scotland (Network Licensee scale) and also to 10 towns further afield in GB. We have assumed that these networks would be constructed 5 years (on average) after Tain.

Table 4.3 – Projected emission reductions arising from broader roll-out

Roll-out scale – central cases	Cumulative savings Thousand tonnes CO$_2$e		
	2030	2040	2050
Network Licensee roll-out scale	40.1	142.0	258.6
GB roll-out scale	64.9	250.7	466.0

Creation of Additional Gas Network Capacity

The development of a standalone gas network, with CNG and compressed biomethane delivered by road, creates additional gas network capacity for consumers. The CNG supply chain acts as a 'virtual pipeline', bridging the gap between the source of the gas (NTS, Lybster, beef farms etc.) and the 'last mile' of the local distribution network. Generally, the supply chain can be scaled up to meet consumer demand provided the standalone network is designed with sufficient capacity. Initially, however, we envisage that the infrastructure installed at Tain would support downstream demand equivalent to one 10 tonne trailer of CNG per day, or c. 132 MWh/day. Table 4.4 quantifies the network capacity released at Project, Network Licensee and GB scales. The latter two figures have been estimated by pro-rating the former using assumed town populations.

Table 4.4 – Network capacity created

Roll-out scale	MWh/day
Project scale	132
Network Licensee roll-out scale	1315
GB roll-out scale	2634

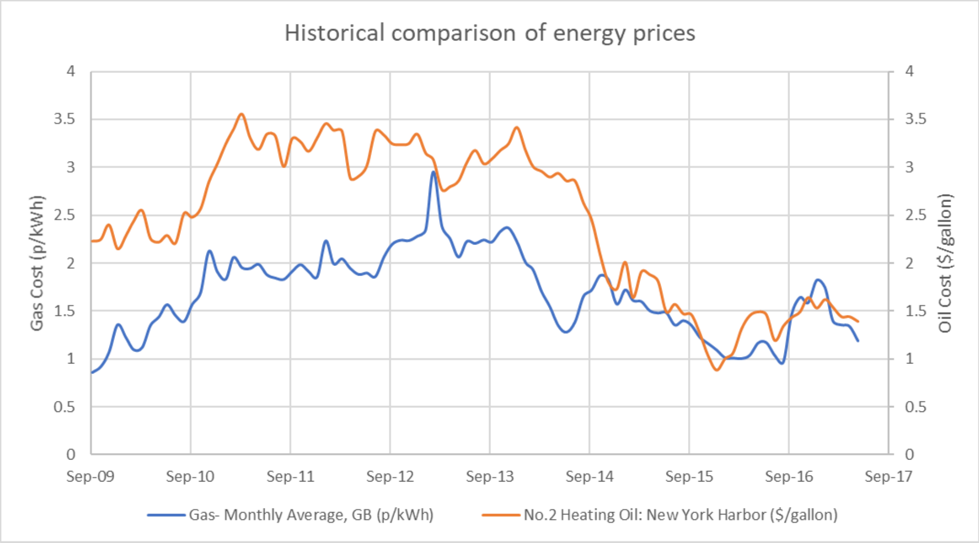
Below we explain that the most efficient method currently in use on the GB transportation system is the delivery of LNG by road, as seen at the SIUs. In theory, capacity could be released as quickly using this method but in practice the economics of delivering LNG mean that it is very unlikely to happen.

Delivery of Financial Benefits

Financial benefits to customers compared with alternative fuels

Those customers converting from electric heating to gas central heating will see a significant reduction in their fuel bill. Typical average prices for electricity on economy tariffs are around 11.4p/kWh[7], whereas our target delivered price of gas for domestic consumers on Tain will be around 5p/kWh (see Appendix B)**.** Even adjusting for boiler efficiency, these customers can expect to make savings of more than 50% of their current heating bill. We estimate that the net present benefit of these savings to 2050 will be around £3.3m in Tain, or £9500 per customer. The current oil price is very similar to our target delivered gas price, but this is in the context of an oil price that is low compared with the recent historical average. Figure 4.5 illustrates the current price of heating oil in a historical context. Customers converting from oil will also benefit from significantly lower price risk since (unlike oil) the bulk of the Tain gas price is independent of the wholesale gas price.

Figure 4.5 – Comparison of historical wholesale oil and gas prices



Any customers currently using oil who install a hybrid heat pump with gas boiler can expect to see an annual saving of around £100 resulting from the efficiency of the heat pump technology. Electricity consumers converting a hybrid system will make much more significant savings. Assuming the customer is an owner/occupier, they will also benefit from an RHI payment for the first seven years. (In other cases, it may be a registered social landlord that receives the RHI payment with the occupier receiving the benefit of the lower fuel bill).

Benefits measured against the most efficient method currently in use

Appendix B explains why the most efficient method currently in use for delivering gas to Tain would be to deliver LNG by road to a standalone network, as happens for the SIUs.

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[7] SSE Total Heat Total Control rate inclusive of standing charge

It also explains how we have estimated the difference between Base Case costs and Method costs. In summary, we have used the level of annual subsidy paid to SGN divided by the typical annual demand within the SIUs to calculate the incremental cost of supplying the SIUs over and above a typical delivered price of gas on the integrated GB network. We have also calculated an equivalent incremental cost for gas supplied as proposed in this project using the Method costs (i.e. those costs that would be incurred if this project were replicated). The difference between Base Case costs and Method costs equates to c. 6.6p/kWh, and in turn leads to the estimated financial benefits for the project shown in Table 4.6.

Table 4.6 – Projected financial benefits from Tain project

Case	Cumulative financial benefits £m		
	2030	2040	2050
Tain – high	6.4	10.3	13.1
Tain – central	5.2	8.5	10.8
Tain – low	3.5	5.6	7.1

Appendix B also describes the methodology used to calculate financial benefits at the scale of a Network Licensee roll-out and at GB roll-out scale. In summary, for distillery towns we have adjusted Method costs for additional efficiencies that can be achieved when standalone networks are rolled out further. We have then scaled the difference between Base Costs and these adjusted Method costs pro-rata to the populations of the towns. For non-distillery towns, we have estimated the additional cost that will arise as a result of not having a very large load to share daughter station costs, and reduced the level of benefits accordingly. Table 4.7 summarises the results for the central case.

Table 4.7 – Projected financial benefits arising from broader roll-out

Roll-out scale – central cases	Cumulative financial benefits £m		
	2030	2040	2050
Network Licensee roll-out scale	30.1	64.6	89.2
GB roll-out scale	56.8	124.9	173.4

(b) Provides value for money to gas Customers

Impact on the GB system operator and benefits accruing to the gas network

As a standalone network, the only impact on the operations of the GB system operator relates to the gas sourced from the NTS at Fordoun. Gas taken from the NTS in this part of the country has little impact operationally, however, and benefits accruing to the gas network from this project are negligible. The initial level of annual demand from the Tain network is anticipated to be around 10 million kWh, approximately 1/85,000th of GB demand (based on 2016 GB annual demand).

Appropriateness of the cost of the Project in relation to the expected learning

The NIC funding requested for this project would result in a one-off cost of approximately 3p[8] to a typical GB domestic gas consumer. For this, hundreds of people could be taken out of fuel poverty in Tain, as explained earlier in this section. In addition, the receipt of NIC funding will give confidence to, and lever support from, other funding sources for gas central heating, insulation etc. It will also allow learning to be captured and shared across a broad range of topics, some of which will be embodied in industry standards under the custodianship of IGEM. This learning will have direct applicability to similar opportunities in Scotland and elsewhere in GB.

Processes used to ensure that the project is delivered at a competitive cost

Highland Council and other appropriate bodies have been consulted to fully understand customer demands and the practical requirements this project will face. The parties have used their professional skill and judgement, reverting to independent experts when necessary, in the scoping, designing and costing of this submission.

We are satisfied that the rates quoted in Table 4.8 are competitive and reasonable. However, before contracts are awarded the competitiveness of the rates will undergo further market-testing. In particular, Fulcrum Pipelines intend to deliver the network construction via Fulcrum Infrastructure Services, its utility infrastructure provider, but will review construction by the employment of direct labour teams or a sub-contractor route to ensure the most cost effective approach.

External funding and Network Licensee contributions are most directly related to customer connections and the associated mains and have therefore been assumed to occur in phase 2.

<u>Table 4.8 – Summary of project costs by phase</u>

		FTEs	Number of days	Average day rate	Labour cost	Equipment	Other	Total
				£	£'000			
Phase 1- frameworks, standards, safety case changes	Staff	[redacted]	[redacted]	[redacted]	99	0	181	380
	Contractors	[redacted]	[redacted]	[redacted]	99			
Phase 2- design & construction of daughter station and network	Staff	[redacted]	[redacted]	[redacted]	1,351	1,465	70	2,970
	Contractors	[redacted]	[redacted]	[redacted]	84			
Phase 3 – hybrid systems trial and knowledge sharing	Staff	[redacted]	[redacted]	[redacted]	47	238	12	379
	Contractors	[redacted]	[redacted]	[redacted]	82			
Total costs					1,762	1,703	263	3,728

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[8] Assumes cost spread over 923 TWh, and typical domestic consumption of 12,500 kWh/annum

Tain consumers will benefit greatly through access to the upstream CNG supply infrastructure at marginal cost as a result of the Glenmorangie scheme, [redacted].

The peak demand management strategy has been chosen in order to provide a broader range of measures to ensure security of supply than simply deploying more storage, and at a lower cost (see (d) below). In particular, the ability to interrupt the gas supply to Glenmorangie distillery provides a very efficient way of enhancing supply security for Tain consumers**.**

How Project Partners have been identified and selected

Our primary project partner, **CNG Services**, approached us about this project, having themselves been approached by the Glenmorangie distillery. CNG Services is a gas engineering company that provides design and build services in relation to biomethane and CNG for trucks. It won the Queen's Award for Innovation in 2016 (for biomethane work) and was responsible for design and build of the LTS-connected Leyland CNG station. The company developed the CNG-to-whisky project that has led to this NIC bid and aims to take CNG to Islay in 2019 to supply 8 distilleries and the domestic market.

Air Liquide UK will manage the logistics of bringing gas to the Tain daughter station and will own the gas as it travels to Tain and when it is in the CNG trailers at Tain. The Air Liquide UK business started as the industrial gases business of Distillers UK, so they have strong relationships with the whisky industry and the necessary CNG competences and financial standing to supply CNG to distillery companies. They have also built, and own and operate, 5 biomethane plants in the UK.

Barrow Shipping will be the shipper on the Tain network. They were selected as they only ship biomethane at present, purchasing biomethane from 33 UK biomethane projects. They will be the gas supplier at Fordoun and it is proposed to use their gas with Green Gas Certificates to supply the whisky industry.

The involvement of the other project participants is explained under (e) below.

(d) Is innovative (i.e. not business as usual) and has an unproven business case where the innovation risk warrants a limited Development or Demonstration Project to demonstrate its effectiveness

Why this project is innovative

The broad concept of this project is innovative: to deliver gas as CNG to a standalone network supplying domestic consumers. This has not been done before in Great Britain, and it requires a variety of new approaches, standards and frameworks. Below we describe the key areas of innovation required to make this happen. Section 6 explains our assessment that the TRL of the project is 7.

<u>Pressure reduction from 250 bar to domestic network pressures</u>

The gas delivered for use in Tain will be in a different state to that delivered to other towns that receive gas by road transport. It will be natural gas (rather than LPG) in compressed gaseous form (rather than liquefied), it will not require the special gas appliances that LPG needs, nor the expensive refrigeration and regasification that LNG requires. It will be natural gas in gaseous form at 250 barg, and will require pressure reduction to 7 barg and then to 75 mbarg for downstream conveyance to Tain.

Ideally, we would be able to use an established IGEM standard for the PRS. However, even though this type of PRS has been used in Europe, the project is the first of its kind in GB and there is no IGEM standard that covers the high-pressure input. The closest existing standard is IGEM/TD/13 ‘Pressure regulating installations for Natural Gas, Liquefied Petroleum Gas and Liquefied Petroleum Gas/Air’. This covers design, operation and maintenance, so would otherwise suit our purposes, but has an upper limit on pressure of 100 barg. Accordingly, we have to take a different approach.

We have therefore approached IGEM and jointly scoped a project to fill a gap through the development of a new standard to cover the required PRS. This will follow the usual development route of IGEM creating a development panel, selecting an author, writing the standard, consulting and after approval, rolling it out.

Maintaining a secure CNG supply for domestic customers

The logistics involved in supplying Tain with CNG make this project unique, requiring innovative thinking in order to establish a robust and economic approach that will ensure security of supply to the town. At first glance it might seem similar to the challenge of supplying the SIUs with LNG, but as we explained in Section 2, the key distinguishing factor is the amount of storage that is available at the SIUs compared with the quantity that we are planning at Tain.

Section 2 outlines the range of measures that will be put in place at Tain to ensure security of supply is maintained. This peak demand management strategy has been developed to mitigate the specific risks associated with delivering gas to Tain consumers. It therefore combines measures designed to build resilience into the supply chain, increase the availability of gas at Tain and manage down the level of demand. This approach is more efficient than solely using storage. To replicate the level of storage we would need a low pressure storage facility, including land, a hazardous substances consent and pressure boosters. We estimate that the additional cost over and above the measures we are planning would be approximately £0.5m.

Use of LPCO device

The inclusion of an LPCO in every Tain meter installation, allows the introduction of an innovative way to restore an interrupted gas network without having to deploy ‘First Call Operatives’ (FCOs) to turn off the gas in each premises after the cause of the outage has been established, and then visit a second time to purge and relight. This has the benefit of speeding up the process of re-establishing the gas supply quicker that on a standard network, and at a lower cost. This approach has never been tried in GB but has been demonstrated successfully on the Isle of Man. In order to utilise the LPCO in the way we have described, modification of the Fulcrum Pipelines Safety Case will be required. Preliminary HSE discussions have been held, and the process is understood. The contracted emergency service provider has also been approached for discussions to agree the changes to enable the proposed ‘way of working’. If the bid is successful, detailed analysis will consider any changes required to call centre scripts, so that Tain calls receive different instructions, and to operational procedures for FCOs.

Improvements resulting from accurate CV measurement and daily meter reading

The natural gas supplied to customers connected to the traditional piped gas network has its volume measured by a meter in each house and its Calorific Value (CV) measured using gas chromatographs in accordance with the Gas (Calculation of Thermal Energy) Regulations. For the purposes of billing, GB is subdivided into thirteen charging areas and a capped average CV is applied, using a complex flow weighted average methodology that uses multiple inputs per area. We only have one entry point to Tain (the blending manifold) so the CV we will use will be more accurate. In addition, we intend to use the functionality of the smart gas meters (AMR for larger non-domestics) described in Section 2, to generate daily consumption figures for use in gas bills.

Furthermore, we plan to use hourly meter readings to build up a uniquely accurate picture of domestic demand patterns, which will help us with supply logistics and also with future standalone network planning. We hope that this information will also be useful for other GTs, and we plan to share it as described in Section 5.

<u>Need for new regulatory/commercial framework to support standalone networks</u>

For the reasons discussed in Section 7, the UNC framework cannot sensibly apply to the Tain network. Furthermore, we believe that the application of ongoing subsidies to support a gas supply to standalone networks of the sort planned for Tain is inappropriate and unnecessary. It is therefore clear that a different framework is required; one that gives sufficient assurance to the Network Licensee to allow the development to take place but that also provides adequate protection to consumers so that they can enjoy the benefit of a competitively priced gas supply. Once developed, this framework can be used in the broader roll-out of standalone gas networks.

Why the innovation warrants NIC support

The level of funding requested from the NIC (£2.14m) is relatively small compared with the total level of related investment. [redacted] Downstream, the additional investment that will be made in the conversion to gas heating systems and insulation (the great majority of which will be through other external funding sources) is itself likely to be more than the value of this NIC bid.

Fulcrum Pipelines does not have the resources to make major investments or to take a material level of risk. Therefore, as we have explained earlier, the one-off costs involved in this project, and the level of risk associated with it, mean that it could not proceed without NIC funding. However, with a relatively modest level of support from the NIC, we can make a real difference to people's lives, deliver environmental benefits and put in place the approaches, standards and frameworks that will facilitate the development of standalone networks elsewhere in Scotland and more widely in GB.

(e) Involvement of other partners and external funding

Tain is in the **Highland Council** local government area. The Council are very interested in our project and we are working with them to help them analyse it alongside other options, prior to them making a final decision on whether to commit the necessary funding. Council funding would cover the cost of new heating systems in their housing stock and contributions towards the cost of connections. They will have access to funding made available by the Scottish Government, including via Scotland's Energy Efficiency Programme (SEEP). See Appendix L.

Albyn Housing Society has over 2,800 properties in 60 communities across the Highlands, including 127 in Tain. The society works in partnership with the local authority, complementing local authority housing provision. They too have a policy to fit gas central heating where possible and again will work with partners to access funding.

It is normal for councils and housing societies to make a capital contribution towards gas connection projects. We cannot be certain of the level of such funding at this stage, as it will be a matter for their boards later in the project. For the purpose of this submission we have assumed a typical level of contribution (c. £900K across the project). Additional external funding is assumed from private householders and I&C customers.

Highlands and Islands Enterprise (HIE) is the Scottish Government's economic and community development agency for the north and west of Scotland, with a remit that integrates economic and community development. They have been key in promoting the project to stakeholders.

The Institution of Gas Engineers & Managers (IGEM) is a professional engineering institution, licensed by the Engineering Council. IGEM are custodians of gas technical standards in GB, developing and maintaining the standards for the benefit of the industry. They have agreed to manage the development of the new technical standards required as part of this project.

The Glenmorangie Company own the Glenmorangie distillery just outside Tain. They are investing in a project to convert their steam raising process to be powered by CNG, and they are keen for the town to share the benefit of bringing natural gas to the area. This project benefits greatly from Glenmorangie’s investment through access to the CNG infrastructure at marginal cost and the ability to interrupt the supply to the distillery.

Imperial College’s Centre for Process Systems Engineering will undertake modelling, design, analysis and optimisation of the system, with a particular focus on the hybrid heating systems trial design. Led by Professor Nilay Shah, an expert on modelling and analysis of energy systems, they have undertaken a wide-range of projects including for DECC, BEIS, ETI, Energy Systems Catapult, EdF, BP and Shell.

IGas Energy plc is a leading onshore oil and gas exploration and production business, holding a portfolio of production and exploration assets including the Lybster field in Caithness. The business has more than thirty years' experience of successfully and safely extracting and producing hydrocarbons onshore in the UK.

(f) Relevance and timing

Decarbonising heat is a highly challenging aspect of the battle against climate change, and progress is slow. Sometimes analysis and debate are easier options than action. This project provides an opportunity to take action now. It would deliver:

- immediate environmental benefits in the form of greenhouse gas emission reductions and improved air quality;
- immediate financial benefits for a community where fuel poverty is high;
- learning that can be applied directly to similar projects, with the potential to replicate the approach at Islay soon afterwards, and;

- the prospect of additional benefits in the future, whether through the widespread deployment of hybrid heating systems in Tain and/or or the injection of hydrogen into the gas mix, neither of which would be possible without a gas grid.

This project is dependent on the separate project to deliver CNG to the Glenmorangie distillery, progress on which is discussed in Section 6.

We note that this is the final year in which bid preparation costs will be reimbursed as part of the NIC process. As an Independent Gas Transporter (iGT), we are unable to support a permanent team working on such projects. To develop this bid, we have had to deploy a small team of consultants and specialist advisors, together with resource from our Project Partners. The cost of this would have been prohibitive if bid preparation costs could not be recovered. This is therefore the only year in which it would be feasible to enter the Tain Innovative Gas Grid into the Gas NIC.

Section 5: Knowledge dissemination

5.1 Learning generated

The project will generate new learning in the following areas:

- Methods for supplying CNG and biomethane to a standalone network: the technical method used to deliver gas to a remote town using 250 barg vehicle-conveyed CNG and then reducing its pressure to 75 mbarg for distribution via a low pressure gas distribution network is a first in GB. We will share details of our approach and the associated changes to our Safety Case.

- Development and trial of approaches to the management of peak demand in a previously untried operational context, thereby ensuring security of supply, by:
  - Gauging the level of customer take-up for connection to a standalone CNG network;
  - Ensuring the resilience of the CNG supply chain, e.g. through the use of Leyland CNG station as a back-up facility;
  - Maximising the availability of gas for domestic customers such as interruptible supply arrangements (with the distillery and possibly others), the retention of a spare CNG trailer and the injection of biomethane;
  - Reducing peak domestic gas demand by facilitating and encouraging improvements in insulation levels;
  - Understanding demand patterns through the analysis of daily and sub-daily data obtained from smart metering.

- Establishment of new regulatory and commercial arrangements for the supply of CNG to a standalone network:
  - The commercial framework that will need to be in place for a network, such as the one we propose, to operate;
  - The regulatory (Gas Transporter & Supplier Licence) framework required to make the arrangement viable for the Network Licensee whilst providing the necessary protection for consumers.

- The installation of LPCO devices to facilitate an innovative and quicker approach to the restoration of gas supplies following a network interruption. The processes associated with a restoration in these circumstances will be defined as part of the Safety Case development.

- The creation by IGEM of two new technical standards, covering:
    - A 250 barg inlet pressure PRS;
    - A combined IGEM PRS3 regulator/LPCO.

5.2 Learning dissemination

We intend to disseminate knowledge obtained in the course of the project as follows:

- General updates to industry and the general public on the progress of the project and an overview of learning. As part of the knowledge-sharing process we intend to set up a 'Fulcrum Pipelines blog' where we can post information. This will be aimed at the industry and will allow users to register for updates;

- Information likely to be of interest to DNs and other iGTs, including methods for supplying CNG and biomethane to a standalone network and management of peak demand in a previously untried operational context. Fulcrum Pipelines attend forums with both the GTs and the iGTs (AIGT) and also have good working relationships with IGEM, the EUA and GISG/GATG. These forums will be used to circulate updates on the project, at the early stages to raise awareness and on an ongoing basis to continue to cultivate support for the project;

- Regulatory and commercial frameworks captured within industry documentation. The commercial and regulatory frameworks will be embodied within industry documentation (licences, network code etc.) and therefore available to all;

- Technical standards. The new technical standards will be developed and published by IGEM. This will ensure that the usual IGEM approach of industry dissemination and consultation is followed in the course of the development process. Once developed, the new standards will be the subject of IGEM journal articles and presentations, and available for purchase from IGEM in the same way as their other standards;

- ENA Smarter Networks Portal. Other learning will be documented and made available to other network licensees via the ENA Smarter Networks Portal;

- Presentations to relevant industry forums, e.g. GDN Collaboration meetings; UK Biomethane Day. We would be pleased to present progress at relevant industry forums, such as the GDN Collaboration meetings.

5.3 IPR

Our bid conforms to Ofgem's principles for disseminating learning from the project as published in the Governance Document.

As described in Section 6.6, the project incorporates a number of technologies that have been tried and tested elsewhere (Commercially-available Off-The Shelf, "COTS"), but have not been integrated in the way we propose in GB. A feature of our approach is that we do not expect the project to generate any substantial Foreground Intellectual Property (IP) that is likely to require any form of protection.

The proposed approach maximises the benefit of COTS IPR application without there being the need to charge development costs to the NIC. We therefore request no funding relating to IPR; an approach which we feel benefits ourselves, Ofgem and consumers.

Section 6: Project Readiness

6.1 Why the Project can start in a timely manner

Project partners

The Network Licensee, Fulcrum Pipelines, has built a project organisation that is capable of starting the project in a timely manner by combining its core competencies of gas distribution network design, build and operation with the complimentary competencies and experience of our partners:

CNG Services Ltd is a company specialising in CNG station, high pressure network and biomethane infrastructure design, build and operation. CNG Services will design and construct the high pressure infrastructure upstream of the Fulcrum Pipelines low pressure network including the 250 barg PRS and the 7 barg regulator described in Section 2.

Air Liquide UK is the UK arm of a multi-national corporation with industry-leading expertise and experience in industrial gases, including CNG. Air Liquide will provide road transport for the CNG mother station(s) to Tain and management of the day-to-day supply logistics.

Barrow Shipping Ltd is a licenced Gas Shipper, specialising in the shipping of green gas. Barrow Shipping will ship gas on the Tain network.

CVs of key individuals from each of the Project Partners can be found in Appendix H.

Other Project Participants are described in Section 4.

Project progress

Fulcrum Pipelines and CNG Services have invested considerable time and resources into the project, and during the period since the Initial Submission CNG Services and Air Liquide UK have made further progress with the Fordoun mother station and the Glenmorangie phase 1 (gas distillery) scheme, pre-requisite projects which were described in Section 2.

Planning permission has been obtained for the Fordoun CNG mother station along with all necessary land options, and the required archaeological investigation is complete. The required twin-stream odorant injection plant has been purchased and mechanical and electrical design work is at an advanced stage. [redacted]

[redacted] To enable the planned first gas in Q2 2018, further design and construction preparation has been made on the proposed Glenmorangie daughter station, which constitutes phase 1 as described in Section 2. The planning application is being prepared, design has been carried out, and civils and other quotations have been received.

[redacted]

Discussions have started with a number of beef/arable farmers in the Inverness area in respect of the production of biomethane and its compression and transport to Tain. The BEIS delay in the proposed new RHI regulations has delayed this part of the project but should not threaten our intended gas supply profile.

We believe that the project plan included in Appendix I is robust, reflecting the significant time and resources that we and our partners have invested in research, design and market testing. Since the Initial Submission, we have developed and in places redefined the programme to allow the whole of 2018 for framework development, customer acquisition and detailed planning. Construction is planned to commence in 2019, with construction of the network extending into 2020. The installation of the first hybrid heating systems would commence following the completion of the first gas service pipes in the latter half of 2019. The extension of the project to 2021 allows time for analysis and reporting of this trial.

Within the plan there are two key go/no-go decision points: the first associated with reaching agreement on the regulatory and commercial framework principles; and the second relating to acceptance by the HSE of the Safety Case, and the threshold for customer take-up being reached, which is largely dependent on funding decisions from the social landlords.

Stakeholder discussions have taken place widely and are at advanced stages. In particular, the key negotiations with distilleries referred to earlier are progressing well. Engagement with other stakeholders including the HSE, Highland Council, Scottish Enterprise, Highlands and Islands Enterprise and the housing societies are positive and ongoing. In particular, we have agreed with Highland Council to work together on analysis of this project alongside other options for future heat provision in their housing stock. This will culminate in a decision by the Council prior to our second go/no-go decision point.

We have received many letters of support: from GDNs, national bodies and local stakeholders, reflecting the level of interest and enthusiasm for the project. These are reproduced in Appendix N.

Project organisation

A Memorandum of Understanding (MoU) has been signed by Fulcrum Pipelines, CNG Services, Barrow Gas Shipping and Air Liquide UK as an interim step prior to entering into a formal co-operation agreement. The MoU establishes a series of principles building upon a shared intention to work co-operatively on the project, covering topics such as project structure, roles and responsibilities, resourcing and costs. The co-operation agreement will formalise these principles and bind all parties to the NIC rules.

The set of commercial arrangements related to the project is illustrated in Appendix H. At an appropriate stage, a licenced Gas Supplier and a Smart Meter Asset Manager will be identified through a competitive selection process.

Appendix H also includes a project organogram and summary CVs of the lead personnel.

Project management and governance

The project structure has been developed to allow delivery of the project to budget and on time whilst meeting the respective requirements of the Governance Document and the needs of the partners' organisations.

The structure flows from the MoU, described above. The governance framework will ensure appropriate oversight and control over key decisions with delivery delegated where most appropriate. The Programme Director is accountable for the allocation of milestones and funding – consistent with the MoU/co-operation agreement - and for reporting to Ofgem. Each Project Partner is accountable for delivering their respective elements of the project. The Steering Committee is made up of representatives nominated by each of the Project Partners and chaired by the Programme Director. It will meet on a quarterly basis to review progress reports, performance against budget, key risks and material issues.

Project risks and the associated mitigation strategies and contingency plans have been identified – see the risk register in Appendix J.

6.2 Measures employed to minimise the possibility of cost overruns

Allowing the whole of 2018 for preparation, customer acquisition and detailed planning will minimise the risk of committed expenditure prior to confirmation that the project can continue beyond the major go/no-go decision points. The additional planning time will also lead to a construction phase that is less likely to require re-work later on.

Competitive procurement processes will be used, following the standard format of preparation of a specification and issue to multiple parties for proposals, following an earlier pre-qualification exercise. As noted in Section 4, Fulcrum Pipelines intend to deliver the construction of the network via Fulcrum Infrastructure Services, but they will review the options of construction by employment of direct labour teams or a sub-contracted route to ensure that the most cost-effective approach is used.

The programme management and governance structure identified above will also reduce the possibility of cost overruns by flagging issues early, thereby enabling mitigating actions to be put in place.

6.3 Data verification process

The data in this submission has been subjected to a verification process whereby it has been checked by a person other than its originator. This verification process is documented by the matrix in Appendix K.

6.4 Delivery of learning if customer take-up is lower than anticipated

As described in previous sections, much of the learning to be generated through this project is independent of the level of customer take-up. The concept of developing a standalone domestic network for the supply of CNG and biomethane will be demonstrated however many customers are connected. Similarly, the learning associated with the use of a 250 barg PRS, the installation of the LPCOs, and the associated technical standards will be unaffected.

The proposed changes to the regulatory framework are required for the concept to be applied irrespective of the number of customers connected, as are the Safety Case amendments.

The project will provide useful learning about customer take-up rates, which will support the planning of subsequent standalone networks. In addition to this, we will receive sub-daily data from each customer who converts to gas and this will help inform demand forecasting in future projects.

We will work with Highland Council to ensure that the hybrid heating system trial comprises 45 hybrids regardless of customer take-up, and will therefore provide the same level of learning in any event.

6.5 Identification of circumstances where the project should be suspended

As mentioned above, we have identified go/no-go points and included them within the programme; namely reaching agreement on the regulatory and commercial framework (see Section 7), acceptance by the HSE of the GS(M)R Safety Case, and the required level of customer uptake being met.

As part of the programme management process, a system will be established whereby any issue with the potential to escalate is identified at an early stage and is flagged to the programme management team, and onwards to the steering committee if appropriate. In most cases, we would expect this process to identify mitigating actions to allow the project to proceed as planned. If this is not possible, we will discuss the potential need to suspend the project with Ofgem.

6.6 Technology Readiness Levels

This project uses, adapts and integrates a number of products and services that, while in use elsewhere, have not been deployed in the operational environment in GB that is envisaged at Tain. Furthermore, they cannot be deployed without new regulatory frameworks and safety case changes being developed.

The project aims to provide a full-scale demonstration in a working environment to test and improve these technologies, and to put in place the associated frameworks, such that they will be ready for commercial deployment on standalone networks elsewhere in GB. We conclude that the overall TRL of this project is therefore 7.

Considering the individual elements of the project:

- A PRS has not been used in GB to reduce pressure from 250 barg to low pressure for use by domestic consumers. The equipment itself is in use elsewhere in the world, but the operating environment is new. Safety Case changes are therefore required, which will be supported by a new technical standard;

- The low-pressure gas distribution network will be fundamentally the same as any other iGT network constructed, owned and operated by Fulcrum Pipelines. The innovation comes from the set of arrangements that allow such a network to be built, the single entry point with its own calorimeter facilitating greater billing accuracy, and through the daily logistics required to ensure that the network is being supplied by sufficient gas;

- The smart meters as proposed will be SMETS 2 standard. The data communications process will be non-standard, however, since consumption data should not become part of the UNC energy balance. We are in discussion with DCC to ensure that their processes can cater for this arrangement, and we have included a small capital sum in our costs to allow for specific development work associated with this requirement;

- The combined regulator/LPCOs that the proposal would place in every domestic meter installation are manufactured in the UK by the manufacturers of the sister product on which they are based, i.e. IGEM PRS3 meter regulators. They are commercially available and have been used with success on the Isle of Man. However, such devices are not covered or anticipated by any GB gas industry technical standard, and the increased efficiency that such a device enables (as described in Section 4(d)) is not contemplated in any mainland GB GS(M)R Safety Case or emergency service provider procedures. Accordingly, some development work and associated safety case change is required;

- The hybrid heating system trial will use established equipment but in a new operational context, to investigate the scope for the heat pump to support the heating requirement at peak times.

6.7 GS(M)R Safety Case implications

As with any other new build Gas Transporter infrastructure, the proposed Tain low pressure network will require a Safety Case under the GS(M)R. Similarly, the proposed CNG Services 7 barg networks upstream of the mother station and within the daughter station will also require Safety Cases.

The Tain low pressure network will be owned and operated by Fulcrum Pipelines, an established licenced iGT, which has the benefit of an existing multi-network Safety Case, and if the Tain network had been like any normal infill project, this would have been sufficient without change. However, initial discussions with the HSE have confirmed that two features of the project, described later, require special treatment through one of the following mechanisms:

- Modification of the existing Fulcrum Pipelines Safety Case;
- Addition of a 'Tain' specific annex to the existing Fulcrum Pipelines Safety Case;
- A new Fulcrum Pipelines Safety Case specifically and exclusively for Tain.

The first driver for customisation is the proposed arrangement for providing security of supply as described in Section 2. The second reason relates to the installation of an

LPCO in each premises as described above. The security of supply provisions in the low pressure network would be reflected in CNG Services' Safety Cases.

Preliminary discussions have taken place between Fulcrum Pipelines, CNG Services and the HSE, during which the proposed innovations have been explained. The HSE have stated that they would like to see formal proposals in due course and that the standard process for draft Safety Case submission/examination would follow.

If we are successful with this NIC bid, Fulcrum Pipelines will lead on discussions with HSE, with CNG Services supporting. In parallel, security of supply changes will be incorporated into CNG Services' daughter station safety case and the Fordoun mother station Safety Case. This process is reflected in the project plan.

Section 7: Regulatory issues

The Tain gas grid will have a number of features that make it unique in the GB gas market. As such, unique licence conditions are appropriate.

Independent Gas Transporter networks exist. However, all the existing iGT networks are physically connected to the GB gas grid. By contrast, Tain will be the first standalone iGT network, with no physical connection to any other network. As such, the standard CSEP (Connected System Exit Point) arrangements are not applicable.

Standalone networks exist, i.e. the SIUs[9]. While not physically connected to the main gas grid, each SIU is owned by one of the DNOs, with regulatory and commercial arrangements applying as if they were part of the main network. Specific Network Code and Licence arrangements are in place to support and operationalise these legacy arrangements, including payment of ongoing subsidies that make this approach feasible. By contrast, no ongoing subsidies are proposed for Tain.

The DNO is responsible for delivering gas to the SIUs. This is purchased from a single Shipper and is allocated to that Shipper's portfolio when entering the network. Gas exiting an SIU network can be allocated to any Shipper/Supplier. In essence, the LNG SIUs have access to the National Balancing Point and are part of the competitive gas market. By contrast, the facilities for entering gas into the Tain network will be privately owned and operated. The owner will be able to determine who has the right to use the CNG daughter station, and hence can effectively determine which Shipper(s) is able to ship gas on the Tain network. The Shipper can choose which Suppliers are able to supply customers in Tain.

In contrast to existing iGT and SIU networks, biomethane may be injected directly into the Tain network. There is no expectation of this being shipped by anyone other than the Shipper used to ship CNG, although the Tain Supplier and the prospective biomethane producer could choose to appoint a different Shipper. An integrated approach is, however, desirable, for commercial reasons, ensuring for example that biomethane is given priority access for injection (potentially avoiding flaring if an AD plant had no

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[9] This summary reflects our understanding but we are not experts in the regulatory and commercial arrangements for the SIUs supplied with LNG. We believe different arrangements apply when LPG is supplied, with no supply competition

access to the network). An integrated approach will also allow CNG deliveries from various sources to be optimised, ensuring all commercial obligations are met while managing costs.

In contrast to existing iGT and SIU[10] networks, there is no prospect of effective supply competition. The integrated approach that is proposed precludes non-project Shippers/Suppliers accessing the gas that will be delivered to Tain, and the scale of the market means that there is no economic case for duplicate entry facilities to be developed. We therefore propose that there should be no obligations to support supply competition. This makes large parts of the existing UNC provisions redundant in the case of Tain.

In addition to defining the framework that supports the registration and transfer of meter points between Shippers, the UNC supports calculations of the national gas balance, with gas allocated to individual shippers at both entry points and exit points. This is also irrelevant for Tain with (near) real-time physical balancing of the network, and all gas entering and exiting being allocated to a single Shipper.

The gas entering Tain from the NTS at Fordoun will already have been accounted for in the national balance, with Fordoun being a standard exit point under the terms of the UNC. As such, no special arrangements are required and there is no need for the gas that has left Fordoun to be accounted for again within the national balance.

By contrast, if Tain were treated as if connected to the main gas network, significant UNC modifications would be required to recognise the unique arrangement. This would involve defining the new concept of a standalone independent network and developing appropriate commercial arrangements to support gas balancing calculations that would net to zero. Fordoun and other network-connected suppliers of gas to standalone networks would probably need specific UNC conditions drafted to define the commercial regime since the proposed use is not envisaged in the UNC. It would also be necessary to consider how to accommodate within the UNC standalone entry points that supply CNG to Tain, such as gas to be delivered from Lybster or from biomethane produced on beef farms that are remote from the existing gas grid.

We do not believe any of this is necessary and that it is simpler and more proportionate for independent standalone networks and gas supplies to sit outside the UNC. As a consequence of this independence and the removal of any obligations to support supply competition, a number of licence conditions are also inappropriate.

For the Tain GT Licence, we would suggest that:

- Standard Conditions 6 should be disapplied with respect to requirements to accede to the UNC;
- Standard Condition 10 (Smart Energy Code) be disapplied;
- Standard Condition 14 (The Supply Point Administration Agreement) be disapplied
- Standard Condition 15 (Smart Metering – Matters Relating to Obtaining and Using Consumption Data) be disapplied.

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[10] Other than LPG supplied SIUs

Consequential changes to other conditions would also be necessary in light of the proposed approach and the disapplications listed above.

In addition to the whole of the UNC not applying to standalone networks, it is proposed that the following iGT UNC sections are inappropriate:

- Part A 4 (Large Transporter Network Exit Agreement)
- Part B (Capacity)
- Appendix CI-2
- Part F (Daily And Annual Quantities And Shrinkage)
- Appendix G-1 RPC Invoice Template[11]
- Appendix G-2 Portfolio Extract File Format

In addition to the significant simplification of the existing regulatory framework outlined above, detailed licence changes may be necessary to recognise the specific circumstances involved at Tain. For example, mandatory use of smart meters together with a LPCO is proposed, and obligations may need to be modified to reflect this.

It is recognised that removal of a number of Licence conditions will create regulatory concerns and we would look to work with Ofgem during Q1 2018 to determine what would be a proportionate regime that properly protects consumers connected to independent standalone networks. We have initiated discussions with Ofgem, which have included suggesting that a price cap applies to the final consumer price, for example a link to the standard gas tariff offered by a gas Supplier.

We are happy to support the development of the licence framework as much as Ofgem would like us to, and have prepared a detailed work-plan for this area of activity, with the associated costs factored into our bid. In addition to developing the Licence requirements, we will write a specific Network Code to reflect the proposed arrangements for Tain, which will be applicable to future standalone networks - a simplified version of existing network codes.

We envisage consulting all potentially interested parties on the proposed regulatory and commercial regime, with the Joint Office mailing lists providing a route to reach the wider gas industry community.

Section 8: Customer Impact

8.1 Customer impact overview

This project will have no impact on existing gas customers, as there are none in the area in which the project is proposed. However, the project will have an impact on our intended future gas customers in two very different respects; the positive opportunity to obtain a gas supply on the one hand, and the potentially disruptive short term streetworks that are necessary to enable this on the other. Accordingly, we propose the

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[11] For the avoidance of doubt, RPC-based GT charges are proposed at Tain, but we do not anticipate them being appropriate for all standalone networks

ongoing interaction described here, which we believe meets and exceeds all conditions set out in the NIC Governance Document.

8.2 Customer engagement in the pre-construction phase

Commencing in the first quarter of 2018, more than 12 months before construction of the network commences, we will begin customer engagement for the process of bringing gas to Tain. Appendix M contains an extract of the project plan associated with this activity and the hybrid heating systems trial.

The way in which we communicate will reflect the fact that we initially intend to focus development on the mains through the centre of the town and the area in the south east where the social housing is concentrated. Discussions with Highland Council and the housing societies will therefore be key in the early months, as will engagement with private home-owners and potential I&C customers along the intended route. Nevertheless, it will be important to reach out to everyone in Tain to ensure that they are aware of the works that will be carried out and the benefits that having a new natural gas supply will bring whether in the initial phase or through subsequent development.

The engagement will commence with the setting up of a new project website, and simultaneously a newsletter will be posted through the doors of Tain residents. These will contain information on the following:

i) Benefits of natural gas: we will explain to Tain's residents that it is the cleanest fossil fuel, and that it is quiet and reliable;

ii) The background to the project including the link with Glenmorangie and the NIC funding, and the phasing of the development in Tain;

iii) How the unique gas supply commercial arrangements will work at Tain;

iv) Smart meters: what they can do, and how they will be installed in the premises of the residents who sign up for a gas supply;

v) The streetworks that will be necessary to install the gas distribution infrastructure.

In respect of the streetworks, we will explain that some roads will have minor restrictions whilst we carry out the works, which could cause disruptions to traffic, particularly due to the small size of the town. However, we aim to reduce such disruption. Where required, clear diversions will redirect traffic as far as possible and we will carefully choose which roads we work on at any one time so that large areas are not disrupted. Where appropriate, we will make use of our latest 'No-Dig' installation technology, using techniques such as moling and directional drilling. This will speed up the installation and reduce disruption to the surrounding area.

Much of the work will require mechanical excavation machines to dig up the road and/or footpath, and create the trenches the pipes will go into, however we will we try to keep disruption as low as possible by keeping the area tidy and by working at times when the roads are not as busy. Although some traffic will be temporally disrupted, there should be no interruption to existing telecommunications and electricity infrastructure.

Our website will be maintained and updated regularly for the period during which construction is taking place, then updated less frequently until the end of the project. As mentioned, the first newsletters will be released as the website goes online, and later editions will be hand delivered throughout the construction period. These will update the residents on the project's progress; complementing the website updates, and importantly, ensuring than any residents not connected to the web are given the information they need.

We will also provide information about the gas service pipe installation methods and connection costs.

We plan to hold one or more 'Town Hall Meetings', which will take place to inform the residents of what the project is, what we will be doing, which streets will be affected, and when. It will be explained that the website and newsletter will hold the latest updates.

8.3 Construction phase communications

The implementation phase of our plan will commence a couple of months before streetworks start. Communications in this phase will be almost entirely through works updates on our website and further hand- or mail-delivered newsletters.

The construction of the gas distribution network will cause some disruption, however as previously mentioned we will be engaging with Tain residents before and during the works. After completion of the initial works, we will maintain the website for as long as it is required, in particular if there are further phases of network extension into streets beyond the initial zone.

8.4 Gas Supplier information

Once appointed in the first half of 2018, our future gas Supplier partner will provide information on contract costs and terms of supply to potential customers, such that they will have all the information required for them to decide whether to sign up for connection after the gas mains installation work is completed.

We will also provide generic information on the meter installation works that the residents will arrange directly with the Supplier.

8.5 GASSAFE Registered Gas Installers

Whilst the selection and appointment of heating and gas installers is outside the scope of the project, it is recognised that the residents of Tain will have no experience of their products and services. Any new installation of gas heating will be between the customer and their preferred gas/heating installer, recognising that the social landlords will constitute the customer for many of the house in the first phase of development. In order to assist the customers without showing preference to any particular installer, information on GASSAFE, the industry register of gas installers, will be provided. From this, each homeowner will have sufficient information to make their own arrangements.

8.6 Insulation (including access to funding)

Alongside the GASSAFE information above, our communications will contain information to encourage customers to make insulation improvements. The information will also be aimed at helping people find access to funding. We plan to invite representatives of the main funding agencies and insulation installers to the Town Hall meetings to support this process.

8.7 Hybrid heating system trial

Our initially thinking is to focus the hybrid heating trial on Council-owned properties. This will have the benefit of providing a single initial point of contact as we seek to find 45 houses that together have the profile defined in the trial design (see Appendix G). If we are unable to find the required profile from Council properties, we will widen the search via the housing societies and potentially private householders. Once the 45 properties have been identified, detailed communication will be targeted to the occupants of the houses and the landlords. Initially this will focus on arrangements for the installation of the hybrid systems. Customer engagement will continue through the period of the trial to ensure that everything is working as anticipated and to collect trial data from the customers as required.

Section 9: Project Deliverables

Reference	Project Deliverable	Deadline	Evidence	NIC funding request (%, must add to 100%)
1	Establish regulatory and commercial framework and safety case changes	Q3 2018	• Regulatory and commercial framework principles agreed with Ofgem and confirmed in communication to the industry • Any required iGT licence and network code changes in place • Any required Supplier licence changes in place • Safety Cases accepted by the HSE	8%
2	Complete community engagement to assess take-up for scheme	Q3 2018	• Levels of customer take-up confirmed following programme of engagement, with customer commitments received • Go / No-Go review meeting held once customer take-up known, with decision documented	2%

Reference	Project Deliverable	Deadline	Evidence	NIC funding request (%, must add to 100%)
3	Develop technical standards for PRS and the combined regulator/ LPCO	Q3 2018	• Finalised version of technical standard for 250 barg PRS published by IGEM • Finalised version of technical standard for combined regulator/LPCO published by IGEM	4%
4	Construction ready to commence	Q1 2019	• GL5 IP approvals obtained • Approved network design plan • NRSWA notices • Any land purchases agreed • Purchase orders for materials & equipment	23%
5	Construct daughter station	Q3 2019	• Daughter Station construction completed and station operational	5%
6	Construct network	Q3 2020	• Gas network infrastructure installed, with customers connected, as evidenced by as-laid drawings and asset records	22%
7	Use smart metering technology to capture daily and sub-daily data	End of project	• Gas customers billed on basis of daily readings • Report on daily and sub-daily gas demand profiles produced and shared	3%
8	Ensure security of supply to gas customers	Q4 2019	• Fordoun diesel genset and UPS in place • Spare CNG trailer in situ • Glenmorangie interruption rights established • Daily supply logistics process established • Telemetry system in place monitoring system pressures	17%

Reference	Project Deliverable	Deadline	Evidence	NIC funding request (%, must add to 100%)
9	Conduct trial of hybrid heating systems	End of project	• Trial design completed • 45 hybrid heating systems installed • Initial data analysis undertaken and shared after first winter of operation • Final analysis of trial completed and documented in report by academic partner	16%
Standard Project Deliverable				
Comply with knowledge transfer requirements of the Governance Document.		End of project	1. Annual Project Progress Reports which comply with the requirements of the Governance Document. 2. Completed Close Down Report which complies with the requirements of the Governance Document. 3. Evidence of attendance and participation in the Annual Conference as described in the Governance Document.	

Appendices

Appendix A: Benefits tables

Method	Method name
Method 1	Tain Innovative Gas Grid

Gas NIC – financial benefits

Scale	Method	Method Cost	Base Case Cost	Financial benefit (£m)			Notes	Cross-references
				2030	2040	2050		
Post-trial solution	Method 1	2.9		5.2	8.5	10.8	Benefits estimated on p/kWh basis, hence related to customer take-up and average gas demand. 2050 range: £7.1m to £13.1m	Section 4 (p. 21) Appendix B (p. 45)
Licensee scale	Method 1			30.1	64.6	89.2	Assumes 11 towns: Tain, 5 other distillery towns and 5 non-distillery towns. 2050 range: £59.0m to £108.0m	Section 4 (p. 21) Appendix B (p. 45)
GB rollout scale	Method 1			56.8	124.9	173.4	Assumes 10 further towns elsewhere in GB. 2050 range: £113.4m to £210.4m	Section 4 (p. 21) Appendix B (p. 45)

Gas NIC – capacity released

Scale	Method	Method Cost	Base Case Cost	Capacity released (MWh/d)			*Notes*	Cross-references
				2030	2040	2050		
Post-trial solution	Method 1			132			Equivalent to one 10 tonne trailer of CNG	Section 4 (p. 20)
Licensee scale	Method 1			1315			Assumes 11 towns: Tain, 5 other distillery towns and 5 non-distillery towns.	Section 4 (p. 20)
GB rollout scale	Method 1			2634			Assumes 10 further towns elsewhere in GB.	Section 4 (p. 20)

Gas NIC – carbon and/or environmental benefits

Scale	Method	Method Cost	Base Case Cost	Carbon benefit (thousand tCO_2e)			Notes	Cross-references
				2030	2040	2050		
Post-trial solution	Method 1			10.3	22.2	35.7	Benefits estimated on per kWh basis, hence related to customer take-up and average gas demand. Would also vary if gas supply profile different from that assumed. 2050 range: 20.8 to 43.5 thousand tCO_2e	Section 4 (p. 18) Appendix D (p. 59)
Licensee scale	Method 1			40.1	142.0	258.6	Assumes 11 towns: Tain, 5 other distillery towns and 5 non-distillery towns. 2050 range: 143.7 to 314.8 thousand tCO_2e	Section 4 (p. 18) Appendix D (p. 59)
GB rollout scale	Method 1			64.9	250.7	466.0	Assumes 10 further towns elsewhere in GB. 2050 range: 252.0 to 567.4 thousand tCO_2e	Section 4 (p. 18) Appendix D (p. 59)

If applicable, indicate any environmental benefits which cannot be expressed as tCO2e.	Air quality benefits through reduction in emission of pollutants from burning oil and coal; in particular, NO_x, PM_{10}, SO_2 and NM VOCs

Appendix B: Calculation of financial benefits

B.1 Determining the Base Case

To estimate Base Case costs, we have to establish the Base Case method. Up until now, the conventional approach to supply an off-grid settlement with natural gas has been to construct a physical connection to the main gas transportation network. An alternative would be to replicate the method in place to supply the SIUs, i.e. to deliver LNG to an offloading installation near to the town. We have interpreted the requirement to identify "the most efficient method in use on the GB transportation system" to mean that we should identify the cheaper of these two approaches.

We have interpreted the requirement this way notwithstanding the fact that the SIU's are a historical legacy from the days of conversion from town gas to natural gas; there has been no new SIU developed since that time. Nonetheless, this method is in use and could potentially be replicated.

Cost of a physical connection

Tain is approximately 20 kilometres from the gas transportation system at Invergordon. We have recently received a quote from SGN for £1.1m for the upstream reinforcement required to supply Tain, however this only includes the chargeable element and we have reason to believe that the full cost would be much higher than this. When the question of a connection was investigated 5 years ago, ESP calculated that the cost of upstream reinforcement would be approximately £20m. Unfortunately, we do not have a copy the report that they produced.

On top of the reinforcement cost would be the cost of a pipeline to the edge of the town. SGN have quoted £7.1m for the connecting pipeline and the network in Tain to supply around 700 consumers. We estimate that around £5m of this would relate to the connecting pipeline.

Cost of 'SIU-style' method

The best data that we have on the cost of an SIU-style approach is the level of subsidy paid by all gas consumers to SGN to cover the incremental costs of supplying SIU customers compared with other GB gas consumers. According to data provided by SGN, the level of subsidy payment for the current year is £14.6m.

SGN have also told us that there are 9300 gas customers in the SIUs, hence the average level of subsidy is £14.6m/9300 = £1570 per customer.

Comparison of physical connection and SIU costs

Each of the two methods identified above would achieve a secure supply of gas at the edge of the town. Under each one, the network in Tain would have to be constructed, but as the costs would be identical in each case, this can be ignored for the purpose of this comparison. We are therefore interested in the SIU subsidy compared with the capital cost of reinforcing the SGN network and connecting it to the edge of the town.

Given the significant uncertainty associated with the cost of the physical connection, we have calculated what the cost of this would have to be for the two methods to be equally economic.

Under our central case, we are assuming approximately 500 customers in Tain initially, and hence our estimate of the annual cost of an SIU-style method is 500 * £1570, or £785,000.

Given an assumption for the capital cost of the physical connection, the annualised cost can be estimated using simplified assumptions of straight-line depreciation over 45 years and a rate of return of 4.95% (based on the pre-tax WACC from RIIO-GD1). Together these give a conversion factor of 7.2%. For a physical connection to be more economic, the capital cost * 7.2% would have to be less than £785,000, implying a capital cost of no more than £10.9m. Given the ESP study referred to above, we think it likely that the full capital cost would be more than this.

Two further points should be noted. First, SGN's reinforcement quotation indicated a 5½ year lead-time, which casts doubt over the suitability of a physical connection as a base case in any event. Second, the cost assessment of the physical connection is a function of the location of the town, the distance from the integrated network and the level of reinforcement required. The cost of physical connection would therefore vary considerably depending on the circumstances, and in rural areas could be significantly higher than estimated for Tain. Specifically, while Tain is 20 km from the integrated gas network, the average distance of our target towns from the integrated gas network is 45 km, with some of those targets having the added complication of being on islands.

For all of these reasons, we have concluded that an SIU-style approach is the appropriate choice of Base Case.

B.2 Comparison of Base Case and Method costs

We have compared the Base Case cost with the Method cost on a p/kWh basis, and used this to calculate cumulative benefits.

Base Case costs

SGN provided us with data on annual SIU demand in tonnes. We have added the kWh/annum equivalent figures into the table below.

Table B1 – SIU annual demand

SIU	Annual Demand (tonnes)	Annual Demand (million kWh)
Campbeltown	2081	30.1
Oban	1987	28.7
Thurso	2890	41.8
Wick	2700	39.0
Stornoway	2863	41.4
Total	12521	180.9

Dividing the annual subsidy by the annual demand gives £14.6m / 180.9m kWh = 8.07p/kWh.

Method costs

To derive the Method costs we have had to estimate the cost of replicating the project at Tain, omitting one-off costs and taking account of efficiencies that could be made with the benefit of experience and repetition. These cost reductions are estimated to be as follows:

- standby diesel generator and uninterrupted power supply to strengthen the CNG production process at Fordoun (£80K)
- establishment of necessary regulatory and commercial frameworks (£78K)
- development of technical standards and safety case changes (£124K)
- hybrid heating system trial (£319K)
- development of data management systems (£57K)
- design and engineering efficiencies for daughter station (£49K)
- project management and reporting (£96K)
- legal, audit and commercial (£62K)

The Method Costs would therefore be Total Costs, £3.73m, less £0.87m = £2.86m

Taking these cost reductions together, we believe it would be possible to achieve a delivered gas price around 25% (1.49p/kWh) higher than a typical standard variable gas tariff[12]. This calculation is set out at the end of this appendix.

B.3 Benefits at project scale

We have used the difference between the SIU-subsidy and the CNG price premium over a typical delivered gas price to estimate the cumulative financial benefit of the project:

SIU-subsidy (8.07p/kWh) – CNG price premium (1.49p/kWh) = a saving of 6.58p/kWh

Assuming annual demand of 9.6 million kWh from the central case, this gives an annual financial benefit of £0.63m.

Cumulative discounted benefits are as shown in the following table.

Table B2 – Cumulative benefits at project scale

Case	Cumulative benefits (£m)		
	2030	2040	2050
High	6.4	10.3	13.1
Central	5.2	8.5	10.8
Low	3.5	5.6	7.1

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[12] Comparison against British Gas SVT with monthly direct debit of 3.80 p/kWh plus standing charge of 26.01 p/day

This table suggests that the breakeven point at which NIC funding would be covered would be reached sometime in the early-mid 2020s, even under the low case. We have also considered the question based on benefits to Tain consumers, taking account of likely initial outlays on central heating systems and the expected split of consumers across existing fuels. On that basis, we would expect a breakeven point to be reached sometime in the 2030s.

B.4 Benefits at scale of Network Licensee roll-out

We intend to roll-out this solution to other distillery towns in Scotland, and then to a number of non-distillery towns. For the purpose of this analysis, we assume that we will roll-out standalone networks to 5 further distillery towns and 5 non-distillery towns.

Distillery towns

When we supply another distillery town we will be able to realise an additional efficiency saving at the daughter station through the sharing of a twin-stream PRS with the distillery. We estimate that this will equate to a further [redacted] saving compared with the Method costs.

Furthermore, with a broader roll-out, future projects will benefit from scale economies within the upstream CNG production and delivery processes, which we estimate will reduce the price of gas delivered to the daughter station by around [redacted].

The combined impact of these efficiency savings is to reduce the achievable delivered gas price by 0.61p/kWh, leading to an additional annual benefit of £59K for a town the size of Tain.

Table B2 identifies the primary target distillery towns together with their respective populations at the time of the 2011 census. At that time, Tain's population was 3655.

Clearly, the towns are quite different in size, and hence the precise costs and benefits associated with each will vary and will only become apparent once a detailed exercise is undertaken for each one. However, the average size of the towns is similar to Tain. For the purposes of this calculation, we have therefore used their combined population in order to provide a scaling factor for the benefits. The combined population in 2011 was 19196, or 5.25 times that of Tain.

Table B3 – Target distillery towns

Town	Population
[redacted]	[redacted]
[redacted]	[redacted]
[redacted]	[redacted]
[redacted]	[redacted]
[redacted]	[redacted]

Cumulative benefits for a town the size of Tain are derived, as described above, but assuming that benefits don't accrue until 2025. These are then scaled for distillery town roll-out by multiplying by 5.25, which gives the following cumulative benefits for the roll-out to the other 5 distillery towns.

Table B4 - Cumulative benefits for roll-out to 5 distillery towns

Case	Cumulative benefits (£m)		
	2030	2040	2050
High	18.0	40.7	56.8
Central	15.0	33.8	47.2
Low	10.0	22.6	31.6

Non-distillery towns

We have identified the following non-distillery towns as primary targets for a roll-out of standalone networks. Their combined population in 2011 was 13563, or 3.71 times that of Tain.

Table B5 – Target non-distillery towns

Town	Population
[redacted]	[redacted]
[redacted]	[redacted]
[redacted]	[redacted]
[redacted]	[redacted]
[redacted]	[redacted]

There are a number of additional factors to consider in relation to the supply of CNG to standalone networks at non-distillery towns:

- Without a very large load in or close to the town, there will be some additional fixed costs, particularly in relation to the CNG Daughter Station. At Tain, many of these fixed costs are being met by Glenmorangie.
- The largest off-grid towns can be chosen, not being tied to towns with distilleries. Nonetheless, the analysis above suggests that these will be on average around 75% of the size of Tain, on a population basis.
- It should be possible to build the daughter station closer to the town than will be the case at Tain, where the CNG will be delivered to a site close to Glenmorangie distillery. This will therefore tend to reduce the fixed cost associated with the approach main.
- With a number of distillery towns connected, the CNG supply infrastructure will provide economies of scale from which non-distillery towns will benefit.
- In addition, the network of distillery towns will provide security of supply benefits for the non-distillery towns through the ability to interrupt supply to the distilleries and the strong fleet of CNG trucks and trailers. This should obviate the need to hold a spare CNG trailer at each town.

It is possible that funding can be sourced to compensate for the additional fixed costs associated with the lack of a distillery, particularly given that the concept will have been fully showcased at a number of other towns. However, without any additional external funding, and taking the above factors into consideration, we estimate that the delivered gas price would be approximately 0.46p/kWh higher than at distillery towns, reducing the annual financial benefit by £44K (for a town the size of Tain).

To estimate cumulative benefits, we have scaled by 3.71 (derived from the populations above) and assumed that benefits accrue from 2025.

Table B6 - Cumulative benefits for roll-out to 5 non-distillery towns

Case	Cumulative benefits (£m)		
	2030	2040	2050
High	12.1	27.2	38.0
Central	9.9	22.3	31.2
Low	6.4	14.5	20.2

Combining the benefits for the project, the other 5 distillery towns and the 5 non-distillery towns gives benefits at the scale of the Network Licensee roll-out.

Table B7 - Cumulative benefits for roll-out at Network Licensee scale

Case	Cumulative benefits (£m)		
	2030	2040	2050
High	36.4	78.2	108.0
Central	30.1	64.6	89.2
Low	19.9	42.7	59.0

B.5 Benefits at scale of GB-wide roll-out

Roll-out elsewhere in GB relies on the development of CNG stations and CNG production and transportation infrastructure. CNG Services is looking for additional sites in England where CNG can be used to fill trucks and supply small gas-fired power plants. Once sufficient infrastructure is in place, the concept will be similar to non-distillery towns in Scotland, with the scale providing security of supply benefits to the standalone networks.

To estimate the benefits at the GB roll-out scale, we have assumed that standalone networks are constructed for a further 10 towns. We are aware that the South West of England and East Anglia, in particular, have many small towns not connected to the gas network – these are the most likely parts of the country for such a roll-out to take place.

In their letter of support for this project (see Appendix N*)* Wales & West Utilities note "that a similar solution could be rolled out to similar off-gas grid communities in the UK where major industrial consumers can leverage the benefits to residents who live nearby." While this is a real possibility, we do not at present have specific information on particular large industrial loads that could fulfil this role during a GB roll-out. For the purposes of this calculation, we have assumed that these 10 towns would have the same characteristics as the non-distillery towns assumed in the Network Licensee roll-out calculation, other than in respect of population where we have assumed that they would be the size of Tain (on average).

Table B8 - Cumulative financial benefits for roll-out at GB scale

Case	Cumulative benefits (£m)		
	2030	2040	2050
High	68.9	151.5	210.4
Central	56.8	124.9	173.4
Low	37.2	81.7	113.4

Table B8 shows the sum of the benefits from Tain, the 5 other distillery towns, 5 non-distillery towns in Scotland and 10 further towns in GB.

B.6 Illustration of delivered price calculation

In the calculations of financial benefits explained above we have referred to estimates of the delivered gas price that we expect can be achieved under the various scenarios. Here we illustrate the calculation of a delivered gas price, which is built on a bottom-up basis. All of the prices are our best estimates, based either on our own cost estimates or on advice from relevant industry participants.

This example uses central case assumptions based on this NIC project:

Cost of gas to daughter station	[redacted] p/kWh
Daughter station opex	[redacted] p/kWh
Network charge	[redacted] p/kWh
Supplier charge	[redacted] p/kWh
Shipper charge	[redacted] p/kWh
Sub-total	[redacted] p/kWh

DCC cost	[redacted] per annum
Metering cost	[redacted] per annum

Average gas demand per domestic	14,813 kWh
Fixed costs expressed on p/kWh basis	[redacted] p/kWh
Estimated delivered price (excl. VAT)	4.69 p/kWh
Estimated delivered price (incl. VAT)	4.92 p/kWh

The benefits calculations use adjusted versions of this delivered price, taking account of the efficiencies identified in the text but also the fact that NIC support would not be received when replicating the project elsewhere.

For example, to establish a delivered price achievable with Method costs, we note that the total project cost is estimated to be £2.86m. Subtracting External Funding (£0.97m) and the Network Licensee Contribution (£0.60m) implies an additional capital cost of £1.29m to be recovered. This equates to £92K per annum using 4.95% return and straight-line depreciation over 45 years, or 1.0p/kWh (incl. VAT) when divided by the assumed level of annual demand in the central case.

Appendix C: Derivation of demand assumptions

C.1 Overview

Precise values for gas demand on the new Tain network will not be known until customers have connected and the gas is flowing. For planning purposes, we have developed scenarios of customer conversion numbers and estimated average levels of gas demand per customer.

These demand cases have been used in order to assess supply logistics, to undertake initial design of the daughter station and the network itself, and to estimate financial and environmental benefits. This Appendix summarises how the demand cases have been constructed. In summary, we have estimated average demand levels by customer type and applied these to assumed customer numbers.

C.2 Domestic customer conversion cases

The initial construction of the gas grid in Tain will focus on the area of the town in which most of the social housing is situated. This is because the social landlords have expressed great interest in the project, have policies to use gas for heating where possible and have access to a number of sources of funding. They also have obligations to achieve minimum levels of energy efficiency, which they will be able to fulfil alongside a gas conversion programme.

However, some of the social housing stock will have relatively recently installed heating systems and there may be a few tenants who are resistant to a central heating conversion. We therefore cannot expect a 100% conversion rate, and accordingly, we have assumed 425 out of 487 social houses convert to gas in this phase, pro-rata to their existing fuel types.

For the private housing stock, we have assumed that initially 75 customers convert to gas in the central case, and that 200 further customers convert in subsequent tranches of roll-out (modelled as all taking place in 2023 for simplicity). This would result in a total take-up rate amongst private houses of around 21%, not untypical of more traditional infill projects. As for social housing, we assume that conversions would be pro-rata to existing fuel types.

The domestic customer conversion cases are shown in Table C.1 below.

Table C1 – Domestic customer conversion cases

Housing type	Assumed conversions								
	High case			Central case			Low case		
	Initial	Later	**Total**	Initial	Later	**Total**	Initial	Later	**Total**
Social	450	0	**450**	425	0	**425**	375	0	**375**
Private	100	250	**350**	75	200	**275**	50	150	**200**
Total	550	250	**800**	500	200	**700**	425	150	**575**

C.3 Annual demand of domestic customers

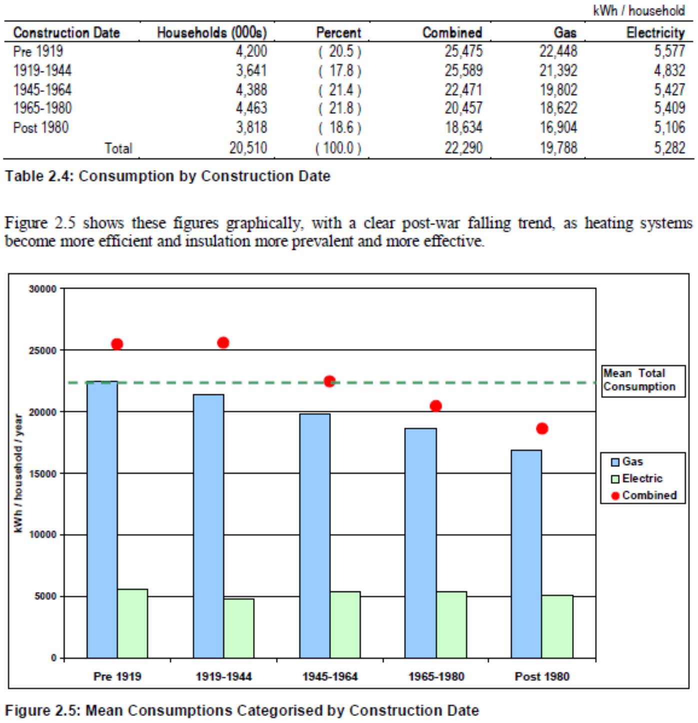
An analysis of the type of housing and weather is usually the starting point for analysis of heating demand. This is then usually compared against UK norms for benchmarking and correction if necessary. A set of techniques can then be used to generate data for peak day and peak hour with reference to average annual demand data.

National norms

We start with UK benchmark data.

Below is some data from a BRE report on fuel consumption[13]. It is UK average data. We estimate that the consumption weighted UK average heating degree days (HDD – a measure of the number of days below 15.5C weighted by the distance from this temperature) will be close to that of Birmingham (2143), while that of Tain is 2645. This measure can be used to infer the heat demand relative to a reference location, so the ratio of HDDs can be used as a scaling factor. Hence, we used a scaling factor = 2645/2143.

Figure C2 – Trends in consumption according to construction date



kWh / household

Construction Date	Households (000s)	Percent	Combined	Gas	Electricity
Pre 1919	4,200	(20.5)	25,475	22,448	5,577
1919-1944	3,641	(17.8)	25,589	21,392	4,832
1945-1964	4,388	(21.4)	22,471	19,802	5,427
1965-1980	4,463	(21.8)	20,457	18,622	5,409
Post 1980	3,818	(18.6)	18,634	16,904	5,106
Total	20,510	(100.0)	22,290	19,788	5,282

Table 2.4: Consumption by Construction Date

Figure 2.5 shows these figures graphically, with a clear post-war falling trend, as heating systems become more efficient and insulation more prevalent and more effective.

Figure 2.5: Mean Consumptions Categorised by Construction Date

Based on this, we would expect the average gas consumption if gas boilers were used to be of the order of 25,000 kWh.

Model-based approach

Next, we develop a model-based approach to the analysis of heat demand. This uses weather data, different assumptions around sample buildings and existing boilers and an energy balance model to estimate heat demand. We assume 9 types of building varying in size (3 levels) and insulation (3 levels) as below.

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[13] https://www.bre.co.uk/filelibrary/pdf/rpts/FuelConsumption.pdf

Table C3 – Basis for 9 building types

Building	Size	U value	Size m2		Average U value	
1	L	L	L	60	L	0.6
2	M	L	M	90	M	0.8
3	H	L	H	120	H	1.0
4	L	M				
5	M	M				
6	H	M				
7	L	H				
8	M	H				
9	H	H				

This gives rise to the following heat and gas demand results for the 9 buildings:

Table C4 – Heat and gas demand by building type (assuming B-rated SEDBUK boilers)

Building type	**Annual (kWh)**	**kWh / HDD**	**Annual gas (kWh)**
1	7,481	2.83	8,699
2	10,984	4.15	12,772
3	14,468	5.47	16,823
4	9,322	3.52	10,840
5	13,729	5.19	15,963
6	18,107	6.85	21,054
7	11,158	4.22	12,974
8	16,462	6.22	19,142
9	21,724	8.21	25,260

Housing stock based data

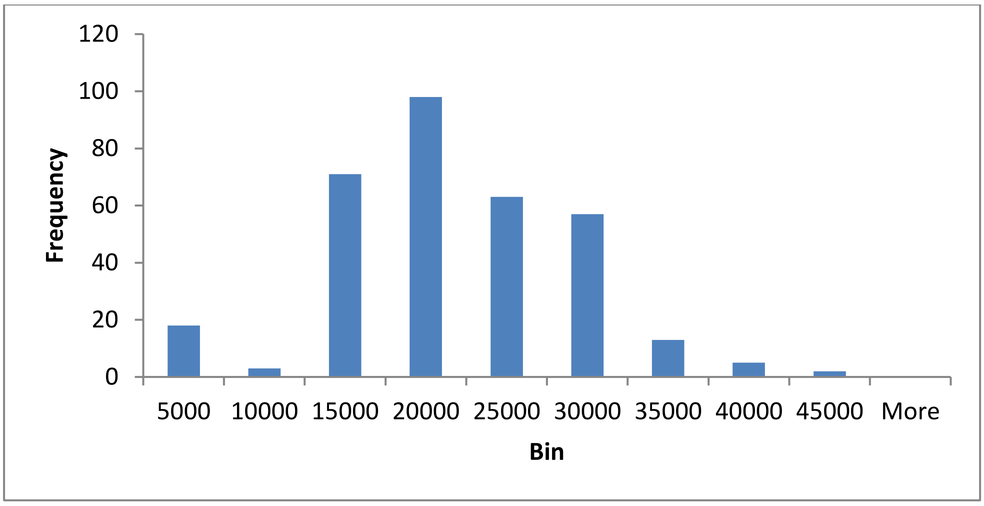
We have data provided by the local authority on all the local residences; this provides both "minimum" and "maximum" estimates of demand. The analyses above and a quick analysis of the Tain data indicate that the "minimum" energy consumption data is likely to be closer to the actual values. These are analysed by category below.

Local Authority (LA) housing stock

The number of properties is 330. The average consumption (min) is 19377 and for max it is 36714.

The histogram for min is as shown in Figure C5.

Figure C5 – Distribution of minimum energy consumptions from housing stock data (LA)

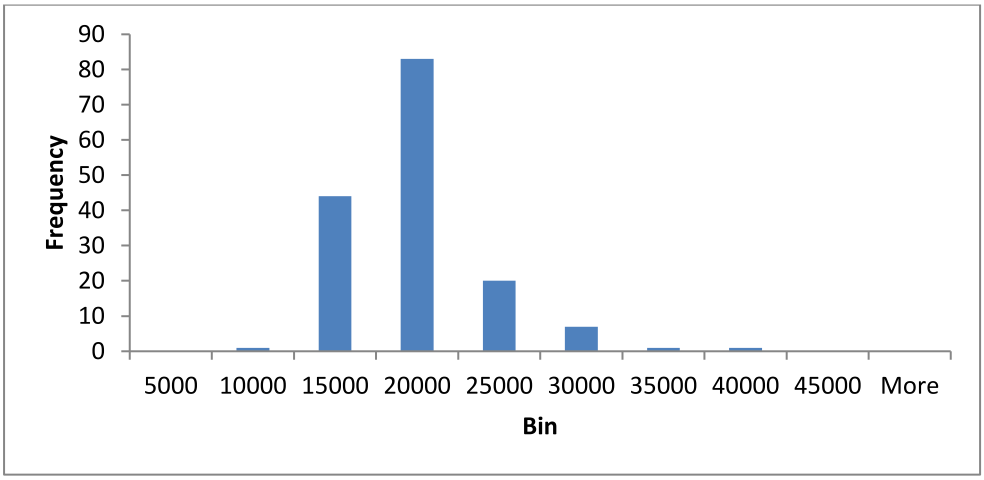


Housing Association (HA) housing stock

The number of properties is 157. The average consumption (min) is 17477 and for max it is 37419.

The histogram for min is shown in Figure C6.

Figure C6 – Distribution of minimum energy consumptions from housing stock data (HA)

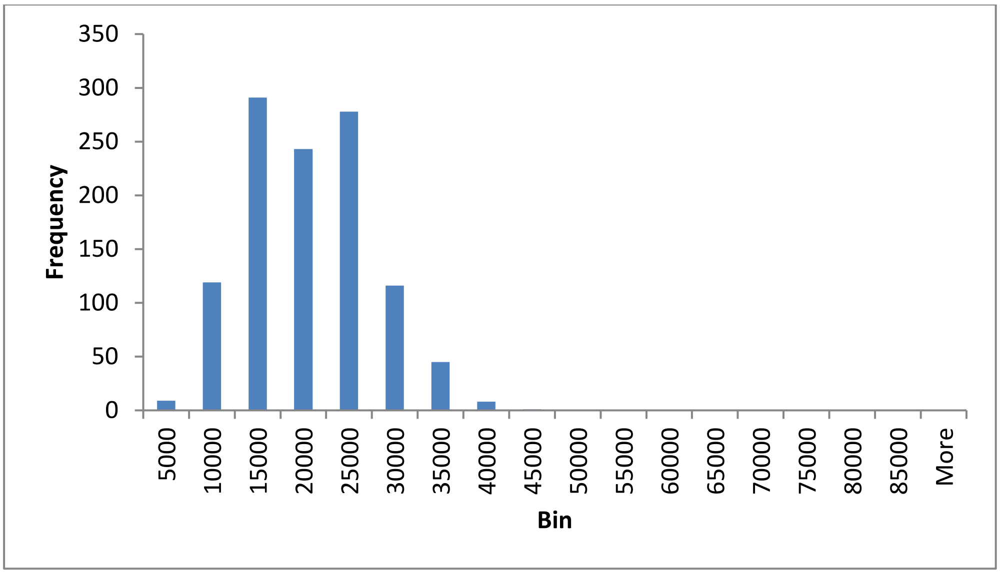


Owner occupied (OO) housing stock

The number of properties is 1110. The average consumption (min) is 18114 and for max it is 36653.

The histogram for min is shown in Figure C7.

Figure C7 – Distribution of minimum energy consumptions from housing stock data (OO)

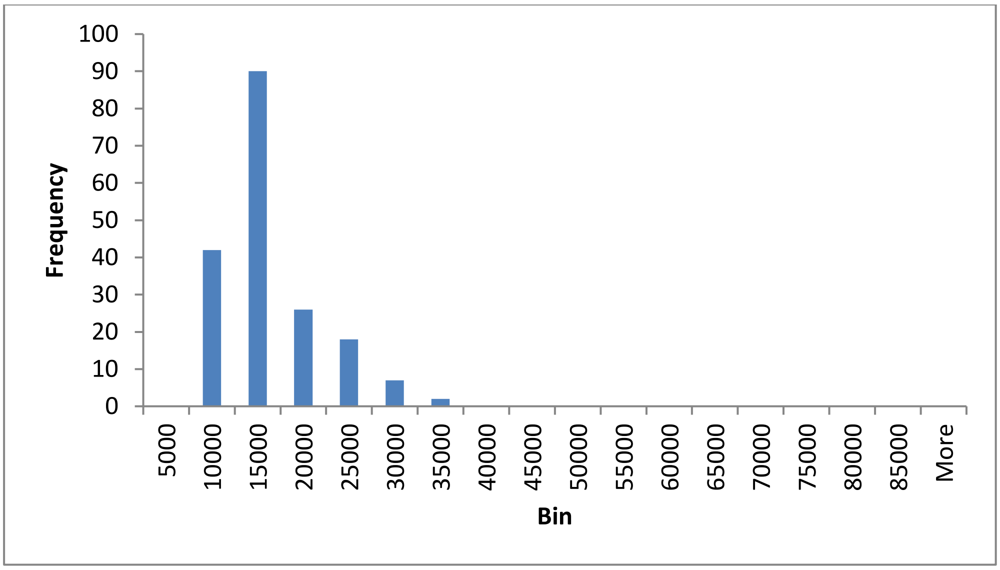


Privately rented (PR) housing stock

The number of properties is 185. The average consumption (min) is 13884 and for max it is 33806.

The histogram for min is shown in Figure C8, indicating a high proportion of flats amongst these properties.

Figure C8 – Distribution of minimum energy consumptions from housing stock data (PR)



We have also had discussions with an energy provider who indicated that typical consumption may be somewhat below the norms that would be expected, maybe suggesting some compromises on comfort. Our most concrete evidence, however, is the dataset provided by Highland Council. Our analysis based on the low estimate of housing energy demand combined with the modelled data and the BRE benchmark data (accounting for the ratio of gas consumption to total energy demand) shows that the LA low estimate is close to our own independent estimates. We have therefore used this as the basis for our high demand case estimates, but have adopted scenarios at reduced levels as the basis for our central and low cases, allowing for a range of behaviour and uncertainty in the nature of the building stock.

In addition, we have assumed a 25% reduction of demand through improved insulation measures. This corresponds to an SAP rating improvement of around 15-20 points and is achievable based on an NEA trial in Worksop[14].

Table C9 – Scenarios of domestic annual gas demand

	Annual Gas Demand (kWh/house)		
	High	Central	Low
Social housing (Local Authority & Housing Association)	17583	15825	13188
Private housing (Privately Rented & Owner Occupied)	16417	14775	12313

C.4 Non-domestic assumptions

While initial construction of the network will focus on the area of the town with the bulk of the social housing, this will require mains to be laid through the town centre, offering the potential to connect industrial and commercial customers that lie along that route. We have assumed that a relatively small number of such customers connect to the gas supply but, given the presence of hotels and supermarkets along this route, that those that convert are amongst the largest of the I&C properties.

In addition, a new community campus is planned for Tain, comprising a large school and library and likely to be situated in a central location. The timing of the Tain gas grid is ideal given the likely timing of the community campus construction. We have therefore assumed (in both the central and high cases) that the community campus would be connected to the gas supply.

Table C10 summarises our assumptions for industrial and commercial (I&C) customers.

Table C10 – Scenarios of I&C annual gas demand

	Average annual demand per customer (kWh)	Assumed number of customers					
		High and central cases			Low case		
		Initial	Later	**Total**	Initial	Later	**Total**
I&C customers	200000	5	2	**7**	3	0	**3**
Community Campus	1180000	1	0	**1**	0	0	**0**

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[14] http://www.nea.org.uk/wp-content/uploads/2015/07/Monitoring-air-souce-heat-pumps-in-domestic-properties.pdf

C.5 Annual demand cases

We derived estimates of average annual demand by combining the customer conversion cases with average annual demands. (For the low case, we combined low domestic conversion numbers with central domestic demand estimates). These estimates were adjusted to account for the lower gas demand associated with the hybrid heating system trial, assuming that gas demand in the trial houses would be only 40% of what would be expected without the heat pump.

Table C11 – Total annual demand estimates (adjusted for heat pump trial)

	Estimated average annual demand (million kWh)								
	High case			Central case			Low case		
	Initial	Later	**Total**	Initial	Later	**Total**	Initial	Later	**Total**
Domestic	9.079	4.105	**13.184**	7.406	2.955	**10.361**	6.246	2.216	**8.462**
I&C	2.180	0.400	**2.580**	2.180	0.400	**2.580**	0.600	0.000	**0.600**
Total	11.259	4.505	**15.764**	9.586	3.355	**12.941**	6.846	2.216	**9.062**

C.6 Peak day and peak hour estimates

Domestic consumers

For 1 in 20 peak day estimates we have applied a load factor of 33.6% consistent with the load factor of the appropriate UNC end user category. Hence peak day = annual demand/365/0.336.[15]

For the peak hour, we have applied a diurnal profile to the 1 in 20 peak day to determine the hour of highest demand: peak hour = 0.0561 * peak day.

I&C consumers

For 1 in 20 peak day estimates we have applied an assumed load factor of 40%, typical of the load factor for an I&C consumer dominated by space heating. Hence peak day = annual demand/365/0.4

For the peak hour, we used data from a range of end users to derive a peak hour to average hour ratio of 4.5.

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[15] The load factor has been applied to annual demands unadjusted for heat pump usage, since prior to the trial we cannot be sure of the performance of the heat pumps at peak times

Appendix D: Calculation of environmental benefits

D.1 Overview of methodology

This appendix explains the way in which we have calculated environmental benefits associated with the project.

The approach is as follows:

a) For a chosen demand case, derive assumptions for the split of existing fuels amongst the consumers that convert to gas;

b) Establish or forecast the carbon intensities of the respective fuels for each year to 2050;

c) Calculate the cumulative carbon emissions from customers who convert to gas i) assuming that they retained their existing fuel, and ii) assuming they are using gas; the saving in carbon emissions for the Tain project is the difference between the two;

d) Scale c) for Network Licensee roll-out and GB roll-out.

Appendix C explains the derivation of our demand cases, while the remaining sections of this appendix explain each of the above steps in turn.

D.2 Fuel type assumptions for customers converting to gas

Highland Council provided us with data on every house in Tain, including the existing fuel type. To utilise this data, we made the following assumptions based on local knowledge and past experience:

- Where Highland's data indicates a fuel type of "biomass/solid" this refers to coal;
- For social housing, anything not shown as electricity we assumed was oil. (Many of these are stated as "communal", and a handful are "biomass/solid", which although probably coal we treated as oil for simplicity – the difference in the final result would be lost in the rounding);
- Industrial & Commercial (I&C) customers have an existing fuel type split of electric (20%) and oil (80%);
- The planned community campus would use oil if gas was not available.

Appendix C documents the assumptions that we have made about the number of customers who convert to gas. To derive numbers split by existing fuel type we have assumed that the conversion of social houses to gas is pro-rata to the number of houses currently using each of the existing fuels. The same principle has been adopted for private houses. In addition, we have assumed that all of the hybrid heating systems are fitted in Council houses currently using oil (an assumption common to all three of the cases).

The resulting customer conversion assumptions are summarised in Table D1 below.

Table D1 – Assumed domestic customer conversion rates

Housing type	Assumed conversions (final numbers)											
	High case				Central case				Low case			
	Elec	Oil	Coal	**Total**	Elec	Oil	Coal	**Total**	Elec	Oil	Coal	**Total**
Social	329	121	-	**450**	310	115	-	**425**	274	101	-	**375**
Private	182	70	98	**350**	143	55	77	**275**	104	40	56	**200**
Total	511	191	98	**800**	453	170	77	**700**	378	141	56	**575**

D.3 Carbon intensities of fuels

We have used greenhouse gas emissions data from the 'UK Government GHG Conversion Factors for Company Reporting' spreadsheet[16]. This contains carbon intensities for combustion and also estimates of "well-to-tank" emissions for the fuels' production and transport. We have combined these figures to give a combined estimate of the greenhouse gas emissions associated with the production, transportation and combustion of each of the fuels (other than electricity and hydrogen).

For hydrogen, we have used the carbon intensities assumed by Cadent's HyDeploy project in their NIC submission, assuming production by electrolysis.

For gas as a whole, a weighted average carbon intensity for each year to 2050 is derived using the assumed gas supply profiles shown in Table 4.1 in Section 1.

To estimate the carbon intensity of electricity we have used National Grid's projections from their Future Energy Scenarios (FES). As the FES scenarios are quite varied, we have used the mid-point of their highest and lowest estimate for each year to 2050.

D.4 Calculating carbon emission savings for Tain

The carbon intensity estimates are multiplied by the respective annual demands of the customers converting to gas to obtain annual estimates of the carbon emissions that would arise were those customers to retain their present fuel. The annual demands are adjusted for this purpose to take account of anticipated insulation improvements that cannot be attributed to this project.

Similarly, annual emissions arising for the use of gas by those customers converting are calculated by multiplying the gas carbon intensity by the derived gas consumption.

Annual carbon emissions savings are calculated as the difference between these 'before' and 'after' emissions and these are used to derive cumulative savings. The results are shown in Table D2 below.

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[16] https://www.gov.uk/government/publications/greenhouse-gas-reporting-conversion-factors-2016

Table D2 - Cumulative GHG emission savings for the Tain project

Case	Cumulative savings (000's tCO_2e)		
	2030	2040	2050
High	12.4	27.1	43.5
Central	10.3	22.2	35.7
Low	6.0	12.9	20.8

D.5 Benefits at scale of Network Licensee roll-out

We plan to roll-out standalone networks supplied by CNG and biomethane to 5 other distillery towns and 5 non-distillery towns in Scotland, as explained in Appendix B.

The calculation of environmental benefits associated with each category is as follows:

Distillery towns

We anticipate that the distilleries at [redacted] will produce biomethane, as is planned at Tain. We also expect biomethane from beef farms to be available for these towns, so we have used the same gas supply profiles to calculate environmental benefits for these towns as we used for Tain.

In order to estimate cumulative savings to 2050 for these 3 distillery towns, we have used the same calculation as for Tain but with customer conversions assumed to take place five years later than at Tain, and customer numbers scaled pro-rata to the populations of the towns (shown in Appendix B).

For the other two distillery towns, we have done precisely the same thing but with revised gas supply profiles in which there is no distillery biomethane.

Non-distillery towns

To estimate emissions savings amongst the 5 non-distillery towns, the methodology is the same as for the distillery towns where we don't expect the distillery to produce biomethane.

Again, the populations of the most likely target towns (see Appendix B) have been used to scale the benefits.

Results

Table D3 shows the sum of cumulative savings estimated, using the method described above, for Tain, the 5 distillery towns and the 5 non-distillery towns.

Table D3 - Cumulative GHG emission savings for roll-out at Network Licensee scale

Case	Cumulative savings (000's tCO_2e)		
	2030	2040	2050
High	48.1	172.7	314.8
Central	40.1	142.0	258.6
Low	20.5	77.5	143.7

D.6 Benefits at scale of GB roll-out

To estimate the benefits at the GB roll-out scale, we have assumed that standalone networks are constructed for a further 10 towns. We are aware that the South West of England and East Anglia, in particular, have many small towns not connected to the gas network – these are the most likely parts of the country for such a roll-out to take place.

In their letter of support for this project (see Appendix N) Wales & West Utilities note "that a similar solution could be rolled out to similar off-gas grid communities in the UK where major industrial consumers can leverage the benefits to residents who live nearby." While this is a real possibility, we do not at present have specific information on particular large industrial loads that could fulfil this role during a GB roll-out. For the purposes of this calculation, we have assumed that these 10 towns would have the same characteristics as the non-distillery towns assumed in the Network Licensee roll-out calculation, other than in respect of population, where we have assumed that they would be the size of Tain (on average).

This results in the emissions savings shown in Table D4, which incorporates the benefits from Tain, the 5 other distillery towns, 5 non-distillery towns in Scotland and 10 further towns in GB.

Table D4 - Cumulative GHG emission savings for roll-out at GB scale

Case	Cumulative savings (000's tCO_2e)		
	2030	2040	2050
High	77.7	304.9	567.4
Central	64.9	250.7	466.0
Low	30.7	132.1	252.0

Appendix E: Additional technical information, maps & diagrams

This Appendix provides more technical details than we could include in section 2: details of the equipment planned for the daughter station, a draft site layout, and maps of the project area including an illustration of the Tain network developments associated with this NIC bid.

E.1 250 barg to 7 barg PRS

This is a two-stage pressure reduction system, reducing the gas pressure firstly from 250 barg to 65 barg and then from 65 barg to 7 barg. A bypass valve system is used to allow gas at or below 65 barg through to the second stage of reduction without using the first. The CNG is pre-heated before both the first and second pressure reduction stages using hot water sourced from the in-built heating system. The boiler to heat this water will take a small parasitic gas load, using approximately 0.5% of the total throughput to pre-heat the compressed gas. The PRS to be used in phase 2 will be designed to have full redundancy to ensure security of supply.

A pressure safety device is installed before the PRS to protect the lines in the case of failure. An automatic shutdown valve, operated using a pressure transducer at the gas outlet, is installed before the first pressure regulator. The second pressure regulator has a slam-shut valve integrated in the same valve that closes for high pressure downstream of the regulator.

The automatic valves for the bypass system are driven by solenoid valves, actuated with compressed air at 8-10 barg using a dedicated instrument air compressor. Similar to the project at Fordoun, it is expected that two air compressors will be installed as part of the infrastructure for supplying Glenmorangie Distillery in phase 1. The air compressors will operate as a duty/standby system to ensure security of compressed air supply. Compressed air will be dried and filtered before being used to actuate any valves.

The PRS will be supplied in an M6 metallic enclosure, with features including a weather-proof roof; particularly important for the harsh weather conditions that are likely to occur in Scotland.

An electrical and control panel will perform the power supply control and operational control functions of the PRS. This panel will be housed in the same container as the PRS, but in a separate, non-hazardous compartment. A data logger system will be installed on the control panel. This will have a touch panel and ethernet connection, and by using a PC, tablet or smartphone browser, it will be possible to monitor and manage all unit parameters via internet connection.

The PRS is estimated to have a delivery time of approximately 120 days from order.

E.2 7 barg to 75 mbarg meter module

The meter module will have a design pressure of 7 barg with an outlet pressure of 75mbarg. Similar to the PRS, it will have a maximum gas flowrate of 1,000 standard cubic metres per hour (scm/h), and will have a twin-stream regulator to ensure security of supply. Filter differential pressure gauges and slam-shut alarm switches will also be included.

The meter module will be supplied with a glass-reinforced plastic (GRP) kiosk, which will be designed to GIS/PRS/35. The module will be delivered to the site using a HIAB with an estimated lead time of 8-12 weeks from receipt of order and approval of all engineering drawings.

E.3 Calorimeter

The calorimeter required is a fast and accurate inferential device which provides an equivalent gas composition whilst also calculating the key physical properties of natural gas: Calorific Value, Wobbe Index, Relative Density, Compressibility, Methane Number, and others. The instrument has no need for calibration or carrier gas, updates every two seconds and has an error on measured values of <±0.5%. The calorimeter is an ATEX/IECEx Zone 1 device with OIML R140 Class A fiscal approval.

A communications interface package which integrates the system's safety interface barriers, a power supply, an Opto 22 micro controller and all ancillary components, will also be provided. The communications package is an easy to use system which is suitable for basic configuration of settings, ongoing data logging and viewing data in a simple format, with many possible client connections such as Ethernet or USB. It is also possible to have the system mounted either to a din rail or into a compact enclosure.

Although this calorimeter is not yet Ofgem approved, it is expected to be by the project start date. If approval has not been gained, a full gas chromatograph will be required at greater expense.

E.4 7-Tonne Advanced Composites 40ft. trailer

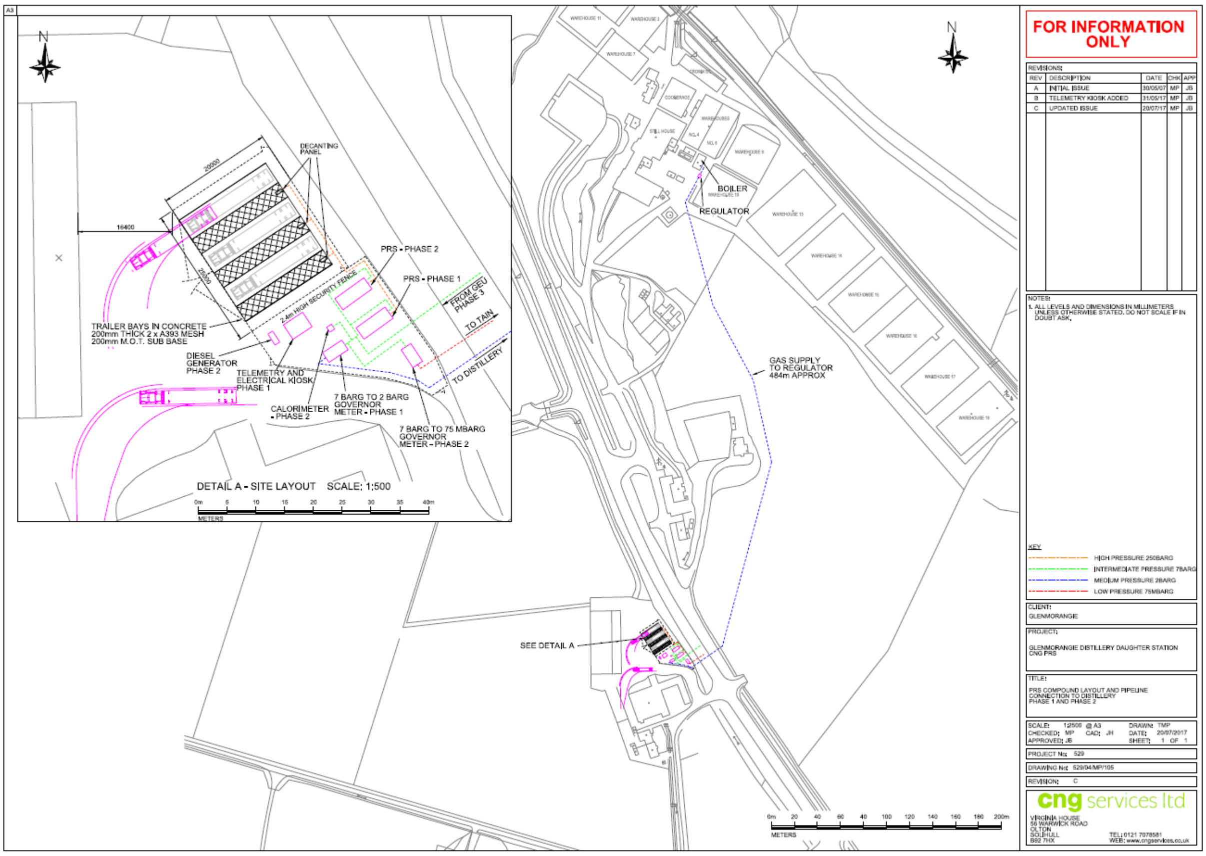
To provide additional back-up CNG storage it is proposed to procure a Type 4 (composite) CNG Storage trailer with capacity of around 7 tonnes of CNG.

The storage will have a working pressure of 250 barg and a possibility to overfill to a pressure of up to 312 barg, as long as the settled pressure is 250 barg.

E.5 Daughter station layout

Figure E1 shows a draft layout for the daughter station with the inclusion of phase 1 and phase 2 infrastructure. It also shows the proposed phase 1 pipeline for linking the station and the distillery boiler.

Figure E1- Indicative Daughter Station Layout



E.6 Maps of Scotland and trailer routes to Tain

The following Figures E2 to E4 show the locations of the important project locations in relation to each other. Indicative trailer routes are also shown for trips between Tain and the mother stations.

Figure E2- Map showing the locations of Fordoun, Lybster and Leyland relative to Tain

E.7 Indicative pipeline routes

Figure E3 shows indicative pipeline route from the daughter station to the Glenmorangie Distillery and to the outskirts of Tain. Figure E4 highlights the indicative mains installation in Tain associated with this project.

Figure E3- Map of the area including North Tain, Glenmorangie Distillery, the proposed daughter station location and indicative pipeline routes

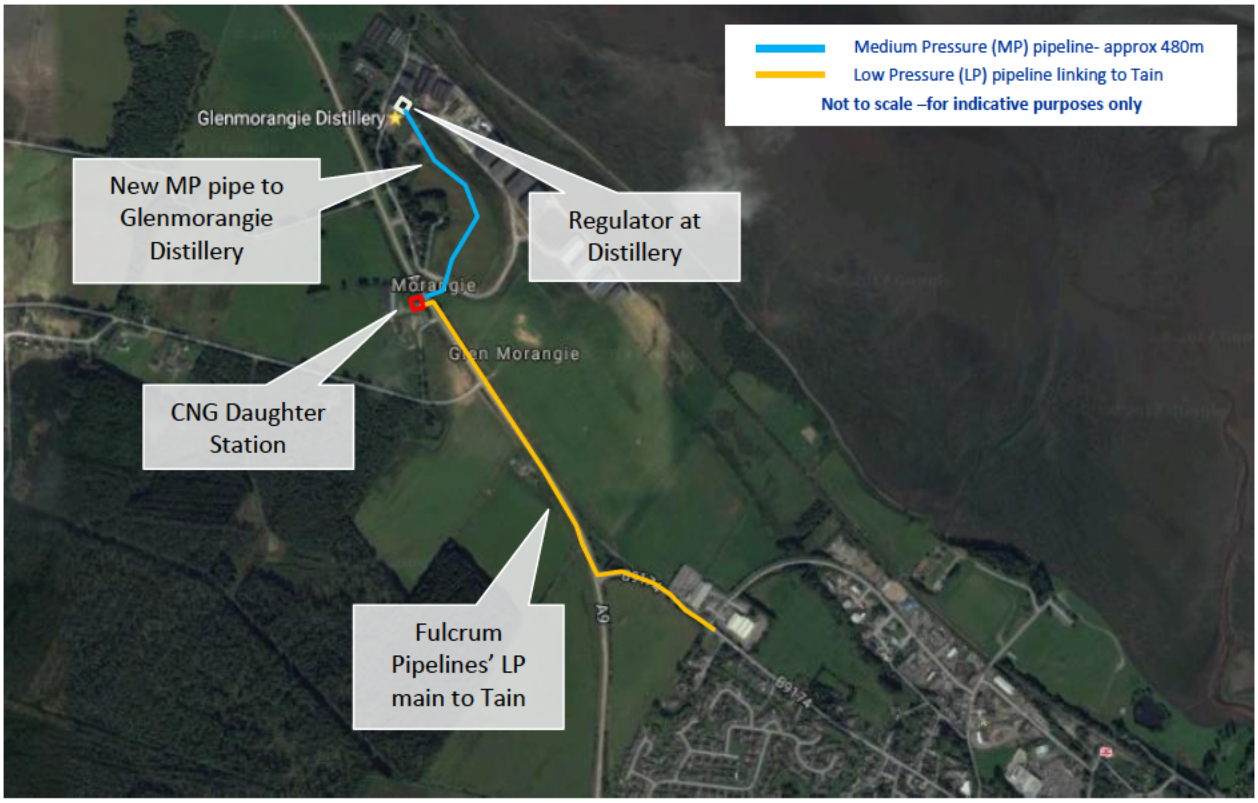
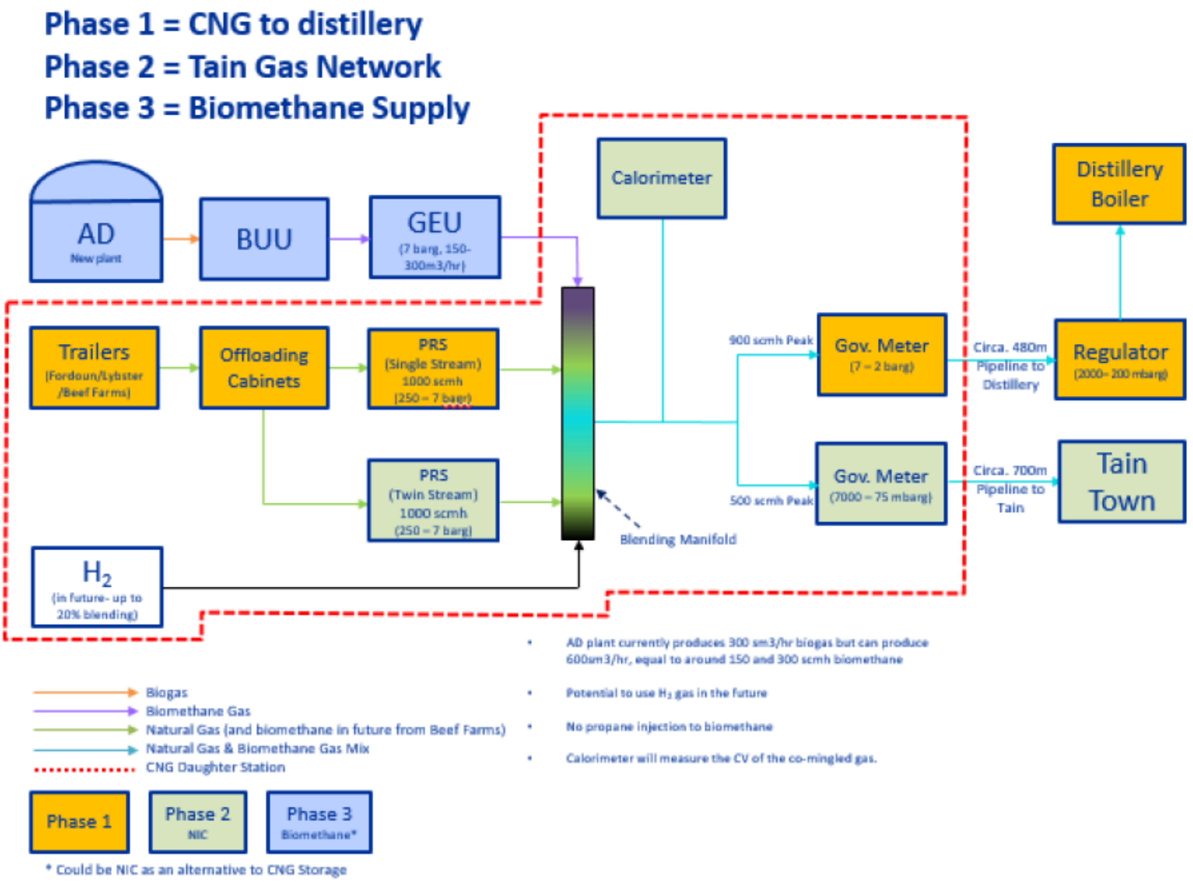


Figure E4 – Map of Tain depicting the indicative scope of mains installation associated with this project

E.8 – Daughter station development phases

Figure E5 – Illustration of daughter station project phases



- AD plant currently produces 300 sm3/hr biogas but can produce 600sm3/hr, equal to around 150 and 300 scmh biomethane
- Potential to use H_2 gas in the future
- No propane injection to biomethane
- Calorimeter will measure the CV of the co-mingled gas.

* Could be NIC as an alternative to CNG Storage

Appendix F: Trailer Logistics Model

F.1 Introduction

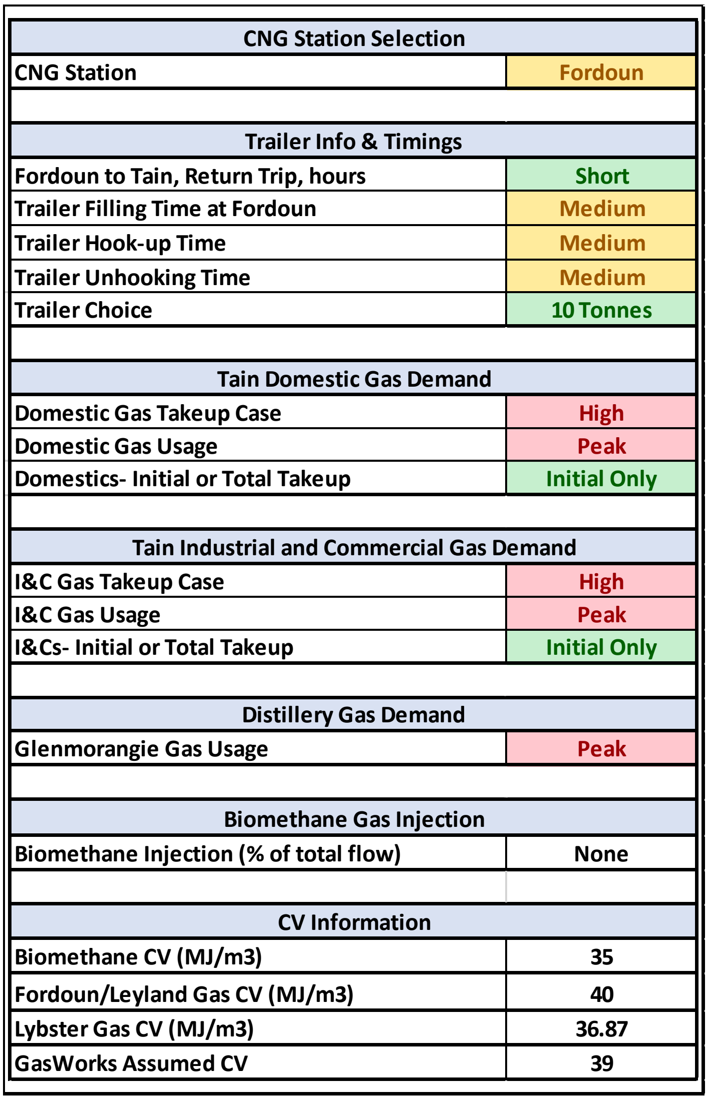
This Appendix covers the mechanisms and outputs of the Trailer Logistics Model. We have used this model to inform our assessment of the infrastructure required to ensure gas supply security to Tain.

The model offers a series of input choices, which, when selected, will output a list of gas demands and timings for the delivery process in a separate table, whilst allowing the user to see if the selected inputs are feasible.

F.2 Inputting values

All inputs can be changed by use of a series of dropdown options. The input cells are shown in Figure F1 below. Selecting the inputs is the only required task to obtain a set of outputs. Inputs are colour coded: green coloured inputs will incur the lowest gas demand and trailer timings, whilst red coloured cells indicate the highest demand and longest timescale options.

Figure F1 - Example Input Selection Pane



CNG Station Selection	
CNG Station	Fordoun
Trailer Info & Timings	
Fordoun to Tain, Return Trip, hours	Short
Trailer Filling Time at Fordoun	Medium
Trailer Hook-up Time	Medium
Trailer Unhooking Time	Medium
Trailer Choice	10 Tonnes
Tain Domestic Gas Demand	
Domestic Gas Takeup Case	High
Domestic Gas Usage	Peak
Domestics- Initial or Total Takeup	Initial Only
Tain Industrial and Commercial Gas Demand	
I&C Gas Takeup Case	High
I&C Gas Usage	Peak
I&Cs- Initial or Total Takeup	Initial Only
Distillery Gas Demand	
Glenmorangie Gas Usage	Peak
Biomethane Gas Injection	
Biomethane Injection (% of total flow)	None
CV Information	
Biomethane CV (MJ/m3)	35
Fordoun/Leyland Gas CV (MJ/m3)	40
Lybster Gas CV (MJ/m3)	36.87
GasWorks Assumed CV	39

CNG station selection

Firstly, it is necessary to select the CNG station that gas will be supplied from; it is possible to choose from Lybster, Fordoun and Leyland. This choice has an effect on timescales. Also, Lybster gas will have a lower calorific value (CV) than grid gas (Leyland and Fordoun); this CV variance is accounted for elsewhere in the model.

Timescales

For the chosen filling station, it is possible to select a return travel time as well as a choice of trailer size. The estimated lengths of time that a trailer will take to fill, hook up (connect with flexible hose) and unhook can also be chosen. A filling time depends solely on the gas flowrate into the trailer from the chosen CNG mother station.

Gas demands

Analysis of gas demand is split between three areas: Domestic, I&C and Distillery. The assumptions used in the calculation of the demand from Tain have been explained in Appendix B. Glenmorangie loads are estimated from oil consumption values and from estimates of future annual loads. An option has also been included to model the injection of biomethane into the system, based on a percentage of total gas flow.

CV Information

CV can vary based on the location of gas supply. Lybster and Fordoun CVs have been calculated from a given gas composition, other CVs are assumed.

F.3 Outputs and other sheets

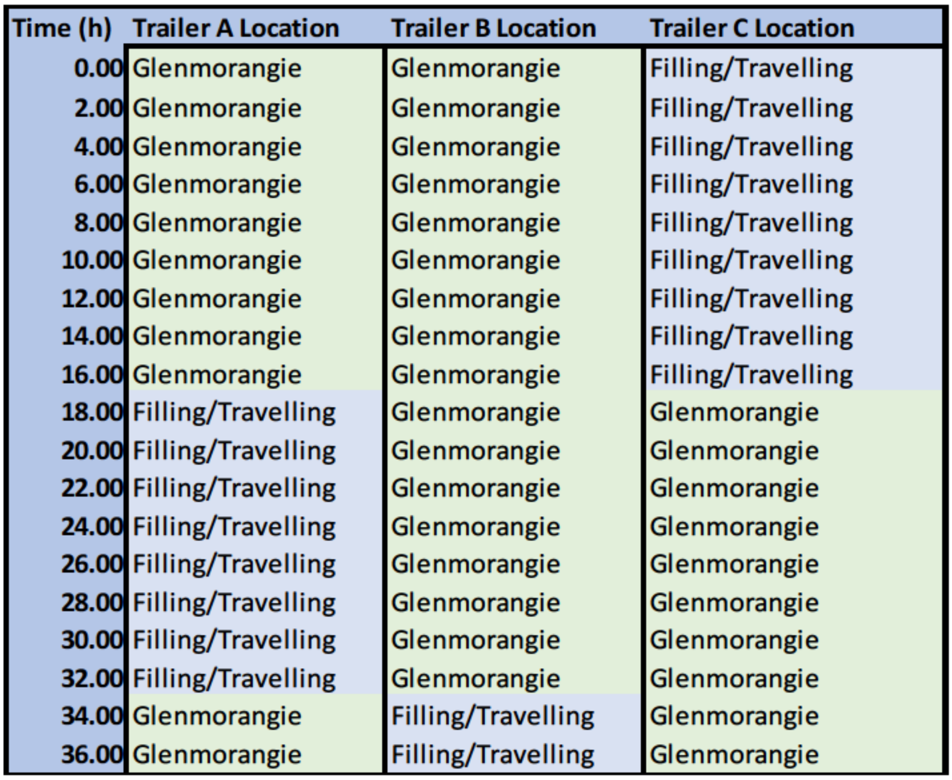
The output table summarises the demands and timings of the process, based on the inputs, and indicates whether a continuous gas supply via trailers is possible. An example output table is shown in Figure F4 at the end of this Appendix, displaying outputs based on the inputs shown in Figure F1.

Trailer Logistics

If feasible, a trailer logistics schedule is created based on the chosen inputs. If the model fails to produce an output, it is deemed impossible to supply gas under the selected demand and time conditions and the assumptions discussed below.

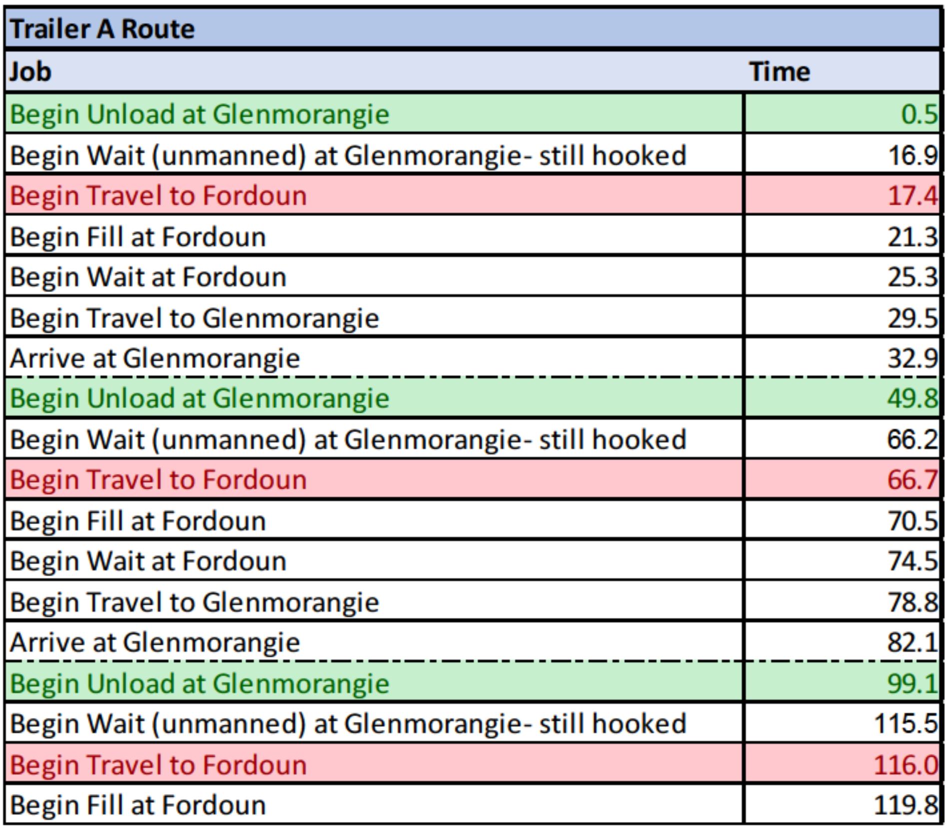
It is assumed that only one trailer will be travelling or filling at any one time and that trailers will unload separately, with supply switching over to the next trailer only when the previous one is depleted. No time is spent by the driver waiting at the daughter station. In high demand conditions, it will be possible to increase the amount of gas transported by operating more than one trailer at a time. Figures F2 and F3 show example outputs from the model. Figure F2 shows the location of each trailer at two-hourly intervals throughout the delivery process. Figure F3 shows a possible trailer schedule for one of the trailers. The outputs from this part of the model include trailer waiting times at both Glenmorangie and Fordoun. These values are used to analyse whether a constant supply of gas is possible using the selected inputs.

Figure F2- Trailer locations at two-hour intervals



Time (h)	Trailer A Location	Trailer B Location	Trailer C Location
0.00	Glenmorangie	Glenmorangie	Filling/Travelling
2.00	Glenmorangie	Glenmorangie	Filling/Travelling
4.00	Glenmorangie	Glenmorangie	Filling/Travelling
6.00	Glenmorangie	Glenmorangie	Filling/Travelling
8.00	Glenmorangie	Glenmorangie	Filling/Travelling
10.00	Glenmorangie	Glenmorangie	Filling/Travelling
12.00	Glenmorangie	Glenmorangie	Filling/Travelling
14.00	Glenmorangie	Glenmorangie	Filling/Travelling
16.00	Glenmorangie	Glenmorangie	Filling/Travelling
18.00	Filling/Travelling	Glenmorangie	Glenmorangie
20.00	Filling/Travelling	Glenmorangie	Glenmorangie
22.00	Filling/Travelling	Glenmorangie	Glenmorangie
24.00	Filling/Travelling	Glenmorangie	Glenmorangie
26.00	Filling/Travelling	Glenmorangie	Glenmorangie
28.00	Filling/Travelling	Glenmorangie	Glenmorangie
30.00	Filling/Travelling	Glenmorangie	Glenmorangie
32.00	Filling/Travelling	Glenmorangie	Glenmorangie
34.00	Glenmorangie	Filling/Travelling	Glenmorangie
36.00	Glenmorangie	Filling/Travelling	Glenmorangie

Figure F3- An example trailer schedule



Trailer A Route

Job	Time
Begin Unload at Glenmorangie	0.5
Begin Wait (unmanned) at Glenmorangie- still hooked	16.9
Begin Travel to Fordoun	17.4
Begin Fill at Fordoun	21.3
Begin Wait at Fordoun	25.3
Begin Travel to Glenmorangie	29.5
Arrive at Glenmorangie	32.9
Begin Unload at Glenmorangie	49.8
Begin Wait (unmanned) at Glenmorangie- still hooked	66.2
Begin Travel to Fordoun	66.7
Begin Fill at Fordoun	70.5
Begin Wait at Fordoun	74.5
Begin Travel to Glenmorangie	78.8
Arrive at Glenmorangie	82.1
Begin Unload at Glenmorangie	99.1
Begin Wait (unmanned) at Glenmorangie- still hooked	115.5
Begin Travel to Fordoun	116.0
Begin Fill at Fordoun	119.8

Figure F4 - Example output table

Description	Value	Unit	Notes
Gas Demands			
Domestic Load	292	scmh	550 dwellings
I&C Load	56	scmh	Using daily flowrates to calculate an average hourly peak flow, assuming only space heating
Glenmorangie Load	413	scmh	
Gas Injection			
Total Gas Flow required from trailers	**761**	scmh	
Biomethane Injection	**0**	scmh	Percentage of total flow supplied by biomethane: High = 15%, Central = 10%, Low = 5% of total demand
Total Gas Flow (inc. biomethane)	**761**	scmh	
Gas Blend Calorific Value	40.00	MJ/m3	
Trailer Volume			
Gas Volume per trailer	13,360	scm	
Usable Gas Volume per trailer	12,496	scm	Total Capacity -Unusable Gas (6%) - Parasitic Gas Load (PRS Boiler) (0.5% of the remainder)
Trailer Timings			
Fordoun to Tain, Return Trip	6.66	hours	Short: 6.66 hours (Google Maps), Medium: 12 hours (Bad Traffic/Weather), Long: 24 hours (Road Closed/Fordoun Failure)
Trailer Set-Off time from Fordoun	3.33	hours	Hours set off before the trailer at Glenmorangie is due to empty
Trailer Filling Time at Fordoun	3.50	hours	Short: 2.5 hours, Medium: 3.5 hours, Long: 4.5 hours
Trailer Hooking-Up Time	0.50	hours	Short: 0.25 hours, Medium: 0.5 hours, Long: 1 hours
Trailer Un-Hooking Time	0.50	hours	Short: 0.25 hours, Medium: 0.5 hours, Long: 1 hours
Trailer Wait Time at Fordoun	4.27	hours	
Trailer Wait Time at Glenmorangie (unmanned)	16.43	hours	
Trailer Emptying Time	16.43	hours	Based on the Gas Flow required and trailer capacity
Minimum time per trailer cycle	49.28	hours	Unload at G'morangie, through the return journey & filling, until the start of another unload- not inc. waiting
Trailer Cycle not including wait times	28.59	hours	Not including wait times
Trailer Usage			
Trailer use percentage (3 Trailers)	58%		If 3 trailers are used, they will be in use (not waiting) for the shown percentage of time
Trailer per day required (Tain ONLY)	0.67	Trailers/day	
Trailers per day required (Total)	1.46	Trailers/day	
Can Three Trailers Supply the Demand?	**YES**		

Total Demand from Trailers	761	scmh	
Max Storage onsite	33,577	scm	Two 10 tonne trailers and One 7 tonne trailer
Storage will last	44.14	hours	

Appendix G: Hybrid heating system trial

G.1 Overall rationale for hybrid heating trial

The principal objectives of the Tain project have been articulated elsewhere. We have identified an additional sub-project which adds significant value to the design and operation of stand-alone networks such as Tain while also providing valuable learning for similar network systems and in support of heat decarbonisation through multi-vector integration in the UK generally.

Our objective was to implement a system that:

- Helps to mitigate peaks in gas consumption during the coldest periods. This has the advantages of reducing CNG shipment frequencies and/or storage capacity

- Complements gas boilers in the transition to low carbon heating

- Is likely to be relevant to large parts of the UK

Although we chose hybrid heat pump technology comprising an air source heat pump and gas boiler, there are other alternatives which were ruled out after preliminary analysis. For example, biomass boilers were considered less desirable due to the complexity of operating two boiler systems that do not typically come as an integrated package provided by a single manufacturer (hence requiring bespoke systems integration) and also need the establishment of a second fuel supply chain. Micro-CHP is another alternative but this does not alleviate the peak demand issue (in fact it would exacerbate it) and also only has the right heat-to-power ratio for a fraction of the year.

Our use of hybrid heating systems of the type proposed here was inspired by their promise in supporting the electrification and decarbonisation of heat while mitigating peak power demand and avoiding stress on both power generation and local distribution[17].

However, our need is inverted, with the need for the heat pump to alleviate some of the demand on the gas system during cold weather, thus reducing supply and hence shipments and storage. The trial will consider the value of such systems on constrained gas networks and also consider the extent to which the electrical network can provide such support without also hitting constraints.

The hybrid system also supports decarbonisation over time, with both input vectors expected to experience reductions in carbon intensity (the gas via use of biomethane and hydrogen and the electricity through grid decarbonisation).

An illustration of the complementary operation of the system is shown in Figure G1 below; this illustrates how the heat pump reduces the demand on the boiler.

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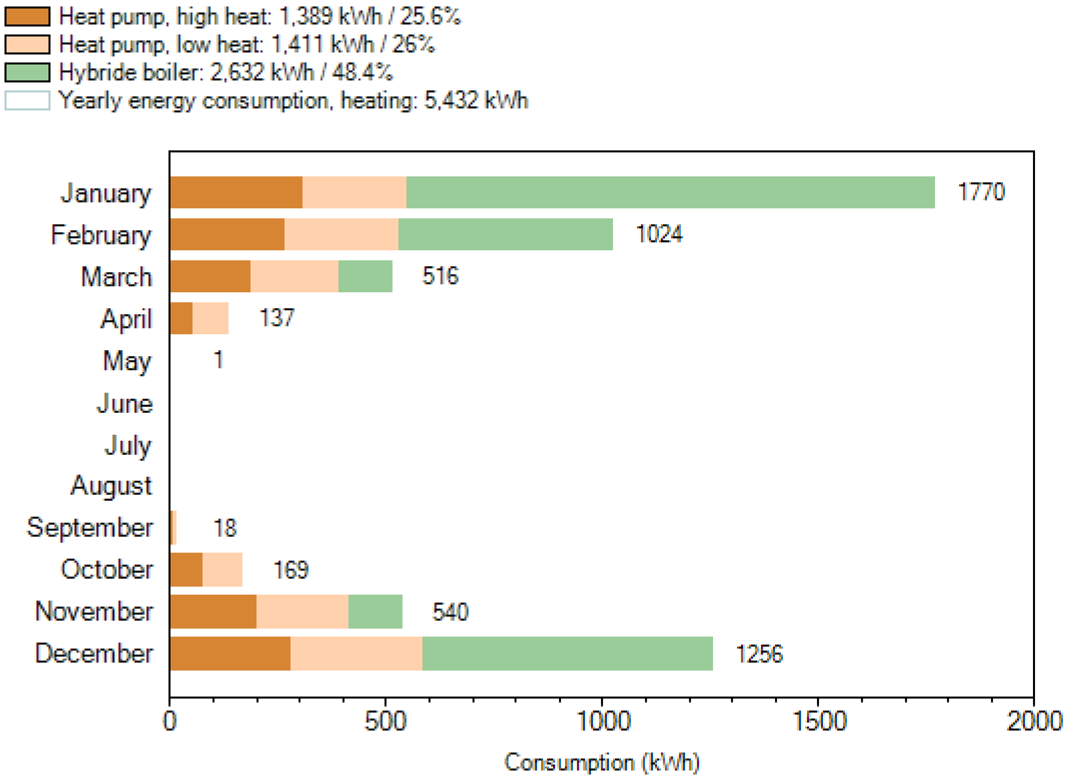
[17] http://eprints.leedsbeckett.ac.uk/3378/3/An%20Exploration%20of%20Load-shifting%20Potential%20in%20real%20in-situ%20Heat-pump%20gas-boiler%20Hybrid%20Systems.pdf

Figure G1 - Heat pump and boiler output



Based on this consideration, we have chosen a particular hybrid heating configuration with three options. Coupled with the need to ensure diversity in the data generated, we have devised a trial employing 45 houses to explore the benefits of the proposed strategy.

G.2 Hybrid heating configuration and operational approach

The hybrid heating system can be set up in three modes via 4-way valve and associated control logic:

(i) Monovalent – either the heat pump or boiler are operational at any time
(ii) Bivalent-parallel – in addition to being able to run alone, the two units operate in parallel and support the secondary circuits together[18]
(iii) Bivalent-series – in addition to being able to run alone, the heat pump can also act as a boiler pre-heater and take advantage of a lower flow temperature to maintain a higher coefficient of performance (hence the boiler acts to "top-up" the heat from the heat pump)

Each of these modes has different merits in terms of the primary objective of providing support to the gas-based heating system and they are all worth exploring to identify the advantages and disadvantages of each in terms of achieving the objective. Hence, we have not chosen a single configuration but all three to explore.

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[18] Only Daikin currently supply an integrated hybrid heating system with the necessary level of control and flexibility for this trial

In terms of operational strategy, the key aspect is to ensure that at times of peak demand (typically determined by a sensor that measures the outdoor air temperature and calibrated according to building information but typically falling below a temperature in the range 2 ° - 5° C) the two elements of the hybrid heating system operate together. This differs from the conventional approach of boiler-only operation under these conditions because the conventional approach mainly takes consideration of loads on the electrical network.

G.3 Design of hybrid heating trial

We plan to implement the trial in 45 homes. This figure was arrived at as follows: we have three configurations to test and wish to use 15 homes for each. The reason for 15 homes comes from a compromise between cost (a pressure to use as few homes as possible) and provision of valuable information (which increases with the number of homes, but with diminishing returns). We have chosen 15 based on a design of experiments (DoE) approach as follows:

- Factors to vary: the key determinants of energy demand are (i) building size; (ii) building insulation quality and (iii) occupant type.
- For building size, we plan to use 3 factor settings (i.e. high, medium and low, typically corresponding to c. 60, 90 and 120 m^2 of floor-space).
- For insulation, we plan to use 2 factor settings (i.e. low, high).
- For occupant type we plan to use 2 categories (i.e. working – hence out during weekdays and retired – hence high levels of building occupation).

Using a pure DoE approach would lead to 3x2x2 = 12 cases; we shall supplement these with 3 random "infill" cases to improve information content and explore curvature with respect to the two factors which only have 2 settings (in the spirit of adding centre points to 2 factors setting DoE).

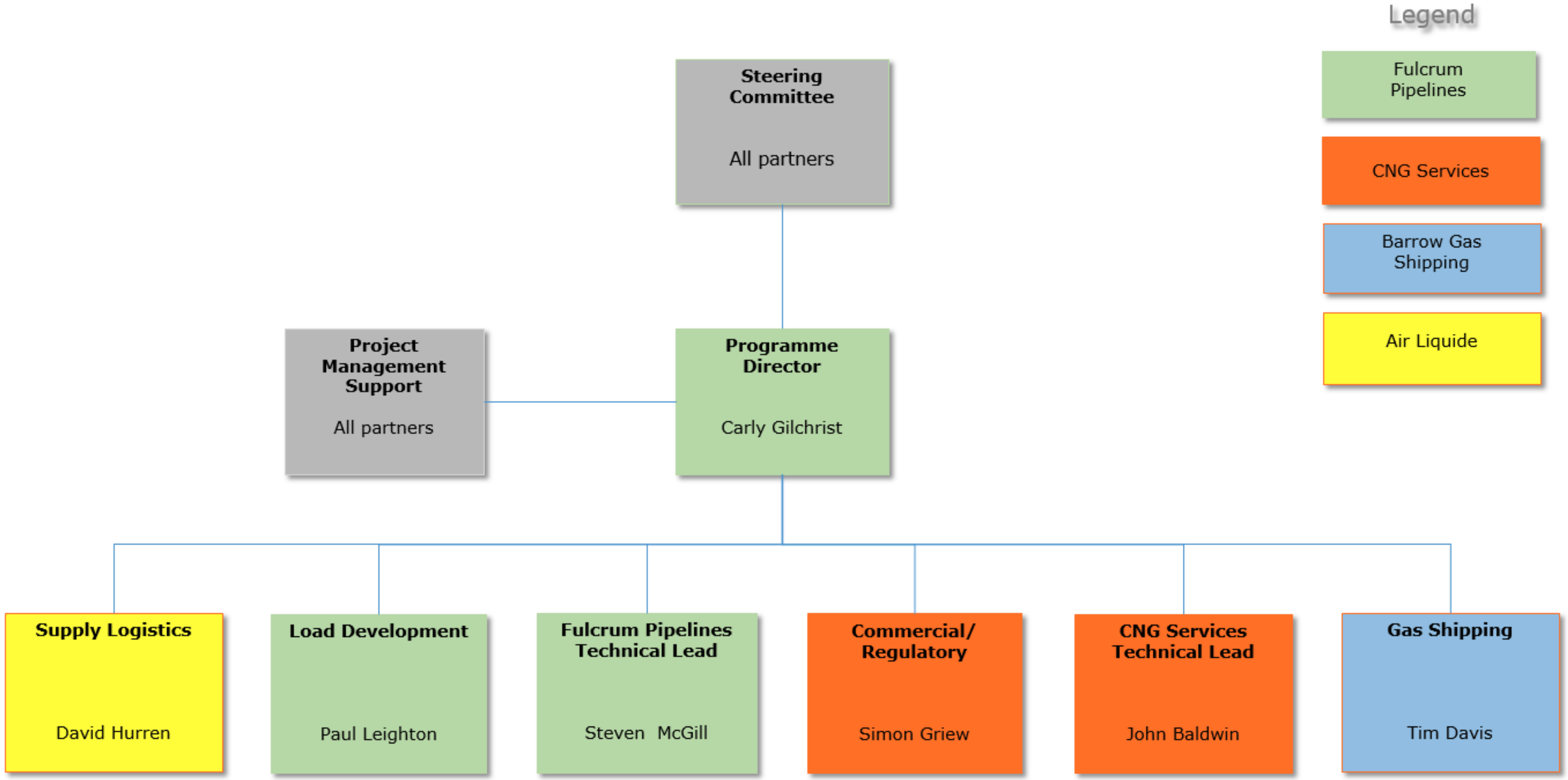
The information that will be gathered during the trial will include the following time series:

- External air temperature
- Internal air temperature
- Internal set point(s)
- Boiler Gas consumption
- ASHP Power consumption

These will be used to evaluate the benefits to the system (in terms of reduced stress on gas supplies at peak time and overall GHG emissions compared to a base case) and the end user (in terms of the annual heating bill compare to a base case) and lessons learnt in terms of how the hybrid heating system may be rolled out across the network and replicated in other stand-alone networks.

Appendix H: Project organisation

H.1 Project governance organogram



H.2 Associated commercial arrangements

Distilleries Project	
Highland Distilleries Project Scope	[redacted]
Parties	[redacted]
Tain Infrastructure Capital & Grants	
Fulcrum Pipelines	Capital funding of the GT network
Highland Council	Capital Grants
Housing Societies	Capital Grants
Ofgem	NIC funding
Gas Consumer Capital & Grants	
Highland Council	Capital Grants
Housing Societies	Capital Grants

Gas to the consumer			
Product Seller / Service Provider	**Customer**	**Product/ Service**	**Notes**
Barrow Shipping	Air Liquide	Gas Sales Agreement	Fordoun
iGas	Air Liquide	Gas Sales Agreement	Lybster
TBC (Beef Farm bio-methane producer(s))	Air Liquide	Gas Sales Agreement	Various
Air Liquide	Barrow Shipping (Shipper)	Gas Sales Agreement	Delivery point is entry to Fulcrum GT Network
Fulcrum Pipelines (iGT)	Barrow Shipping (Shipper)	Network Code	Simplified version for transportation through the iGT network
Barrow Shipping (Shipper)	TBC (Gas Supplier)	Gas Sales Agreement	
TBC (Meter Asset Manager)	TBC (Gas Supplier)	Meter Rental & Maintenance	Modified version of Industry Standard
Data Communications Company (DCC)	TBC (Gas Supplier)	Service Agreement	Modified version of Industry Standard
TBC (Gas Supplier)	Consumer	Gas Supply Agreement	Modified version of Industry Standard

H.3 CVs

Carly Gilchrist

Carly Gilchrist joined Fulcrum in September 2009. She has undertaken various roles within Commercial, Operations Support and Asset Management functions. Between 2012 and 2014 Carly was Commercial Manager, managing the framework agreements for the delivery of Fulcrum's work with their framework partners. Carly joined the Executive Team in January 2015 as Head of Commercial. During this period Carly secured an MSc in Quantity Surveying and was awarded young person's achievement award at the 2015 Gas Industry Awards. Carly took on the Asset Director position in May 2017, a role that combines the management of the Fulcrum Pipelines business, the set-up of the new electric asset management business and operations support activities.

Paul Leighton

Paul Leighton started his gas industry career in 1977 as a distribution craft apprentice, since when he has held a number of high profile roles at senior level throughout the industry. He was instrumental in setting up and running the independent gas transporter Fulcrum Pipelines Limited. Paul has a deep knowledge of all aspects of the gas transportation business and has also been involved with the design, installation and project management of many large projects at all pressure ranges up to 7 barg. In 2014, Paul won the IGEM EUA Engineer of the year award for the Olympic park project, delivering gas to the Olympic cauldron. He is currently heading a project to further expand the Fulcrum Pipelines network portfolio.

Steven McGill

Steven McGill is Area Operations Manager Scotland for Fulcrum Pipelines. He is a member of IGEM with over 25 years continuous gas industry experience for British Gas, Transco, SGN and Fulcrum Pipelines. His roles have included Gas Distribution Apprentice, Engineering Technician, Engineering Officer, and Operations Manager. Steven has had experience in designing, building and delivering gas infrastructure projects safely to domestic and commercial properties.

John Baldwin

John Baldwin is Managing Director of CNG Services Ltd. John's company provides design, consultancy and project delivery services in relation to:

- Injection of bio-methane into gas distribution networks
- Injection of shale gas into NTS and gas distribution network
- Development of CNG filling stations
- Use of CNG to supply off grid industrial customers (e.g. distilleries)
- Connections of 10 – 50 MW gas engine power plants to the gas grid.

John is a former President of the SBGI (Society of British Gas Industries, now known as the EUA) and is Chairman of the Renewable Energy Association Biogas Group.

Simon Griew

Simon Griew is an independent consultant and associate of CNG Services. He has 30 years' experience in a broad range of strategic, commercial and regulatory roles in the energy industry, the majority of which were in senior management positions for National Grid and its predecessor gas companies. Early in his career, Simon was one of Transco's negotiators in the original development of the GB Network Code. Since becoming an independent consultant in 2013, Simon has completed a wide variety of assignments including the provision of advice to Ofgem on licence implications arising from National Grid's recent DN sales process. Latterly, he played a lead role in the development of this NIC bid. Simon chairs IGEM's Finance Committee and is a member of the IGEM Council.

David Hurren

David Hurren is CEO of Air Liquide Advanced Businesses and Technologies. He has a current emphasis on developing profitable growth through customer service and solutions. The focus is on specialty gases (pure gas, mixtures & pure hydrocarbons plus installations); helium (liquid supply and recovery); hardware (CO2 Equipment - pumps, vaporizers etc.) along with Hydrogen Energy and Biomethane (Gas to Grid & Vehicle Fuels). Air Liquide have installed 11 biomethane upgrading plants in the UK.

David also chairs BCGA (British Compressed Gas Association) Technical Sub-Committee on Hydrogen and Compressed Gas Energy, which in 2014 published CP41, "Design, construction, maintenance and operation of filling stations dispensing gaseous fuels".

Tim Davis

Tim Davis is Managing Director of Barrow Shipping Limited, a specialist biomethane Shipper and Supplier. The role involves taking responsibility for all aspects of the gas shipping business and its development. Tim is also an independent consultant and associate of CNG Services, providing support and advice on issues which go beyond the scope of Barrow Shipping. This focuses on regulatory and commercial developments, drawing on experience in a range of senior roles at National Grid and its predecessor gas companies, but also a range of roles as a member of The Government Economic Service, including Director Regulation and Business Affairs at OFFER.

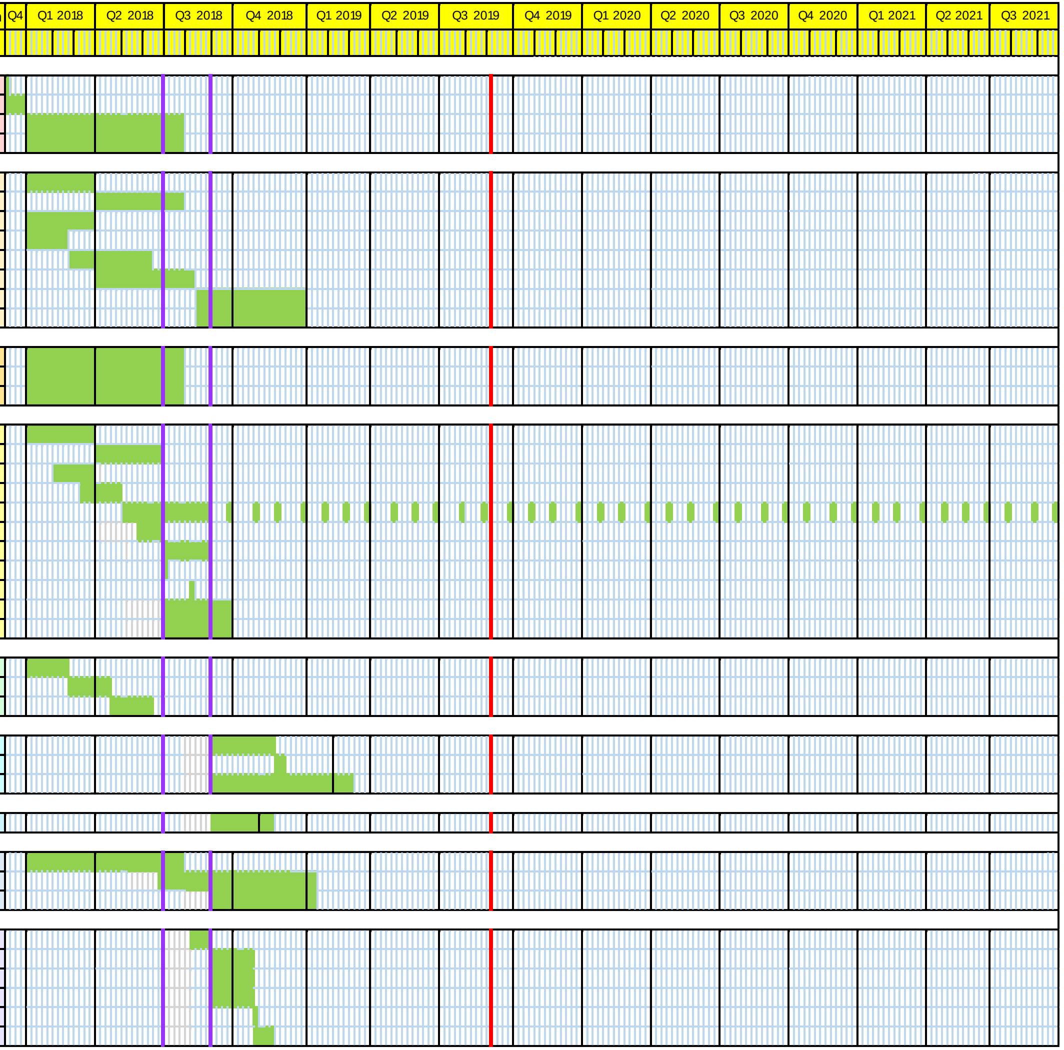
Professor Nilay Shah

Professor Nilay Shah was the director of Centre for Process Systems Engineering (CPSE) and is now Head of Chemical Engineering at Imperial College. He has a Master's degree and PhD in Chemical Engineering. His research interests include the application of multiscale process modelling and mathematical/systems engineering techniques to analyse and optimise complex, spatially- and temporally-explicit low-carbon energy and industrial systems, including bioenergy/bio-renewable systems, hydrogen infrastructures, carbon capture and storage systems and urban energy systems. Nilay has been involved in a large number of related projects in the field of low carbon and efficient heating systems and works with a large number of end user companies and organisation such as the ETI, Energy Systems Catapult, BEIS and the Carbon Trust.

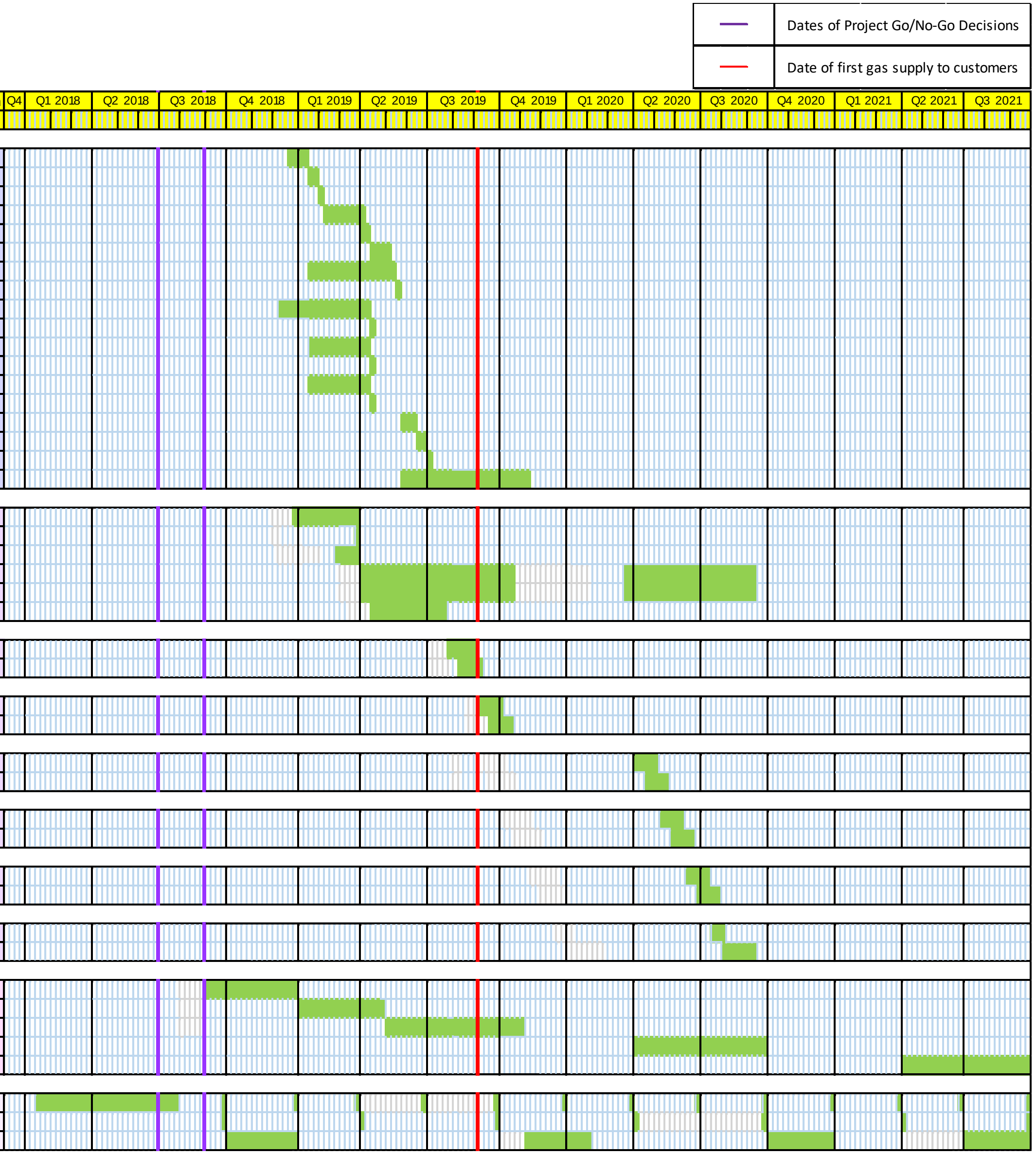
Appendix I: Project plan

—	Dates of Project Go/No-Go Decisions
—	Date of first gas supply to customers

Task No.	Tain Gas Supply Programme	Lead Party	Duration Weeks
Project Preparation, Planning & Initial Documentation			
11	Confirmation of NIC funding	CNG Services Ltd.	1
12	Project Mobilisation		4
13	Establish IGEM LPCO Standard		30
14	Establish IGEM PRS Standard		30
Commercial and Regulatory Framework			
2.1	Choose and prepare a contract with a Gas Supplier	CSL/Fulcrum Pipelines	13
2.2	Prepare an offer and a contract for customers in Tain	Gas Supplier	17
2.3	Develop commercial model and any other associated contracts	Various	13
2.4	Develop regulatory principles	Fulcrum Pipelines & Ofgem	8
2.5	Obtain licence derogations		16
2.6	Agree Price cap		19
2.7	Develop network code and supporting documents		21
2.8	Obtain supplier and iGT licences		21
Operations			
3.1	Agree emergency procedures with SGN or others	Fulcrum Pipelines	30
3.2	Create Safety Case and obtain HSE Consent		30
3.3	Prepare a contract with NG/Cadent for an 0800 emergency number		30
Stakeholder and Community Engagement			
4.1	Support Council's analysis of project	Fulcrum Pipelines/CNG Services Ltd - Stakeholder and Community Engagement	13
4.2	Ongoing engagement to support Council's decision-making process		13
4.3	Develop Community Engagement Plan		8
4.4	Develop project website		8
4.5	Maintain project website		54
4.6	Marketing literature for conversions		5
4.7	Town hall meetings & further community engagement		9
4.8	Newsletter 1		1
4.9	Newsletter 2		1
4.10	Sign up consumers (gas supply)	Gas Shipper/Supplier	13
4.11	Sign up consumers (infrastructure)	Fulcrum Pipelines	13
Metering Preperation			
5.1	Prepare 'Smart' metering/AMR proposal	CSL/MAM	8
5.2	Design and cost Meter installation model		8
5.3	Prepare data capture, analysis and dissemination proposal	MAM	8
Network Design			
6.1	GT Network detailed design	Fulcrum Pipelines-Design	12
6.2	Network Design approval obtained		2
6.3	Legal/Easement Requirement assessed and instructed		27
Additions to Fordoun Mother Station			
7.1	Order/Install 500kVA Diesel Genset & UPS	CNG Services Ltd.	12
CNG Daughter Station Regulatory Requirements			
8.1	Develop Safety Case and any rqd. additions to Fulcrum safety case	CNG Services Ltd.	30
8.2	Obtain HSC for the Glenmorangie/Tain Daughter Station		30
8.3	P Pipeline GL5/G17 provision under PSSR		20
CNG Daughter Station Additions Detailed Design			
9.1	Initial Site Layout	CNG Services Ltd.	4
9.2	Site Civils Detailed Design Period		8
9.3	Site Electrical Detailed Design Period		8
9.4	Site Mechanical Detailed Design Period		8
9.5	HAZOP		1
9.6	Site layout reviewed/approved		4



Task No.	Tain Gas Supply Programme	Lead Party	Duration Weeks
CNG Daughter Station Additions			
10.1	Tender period equipment & civils	CNG Services Ltd.	4
10.2	Appoint Civils contractor		2
10.3	HAZ D		1
10.4	Civils construction		8
10.5	P Pipework & Associated Connectors Order/Delivery		2
10.6	P Pipework Installation		4
10.7	Twin Stream PRS order/delivery 250-7 barg		17
10.8	Install PRS		1
10.9	Meter with Twin Stream Regulator Order/Delivery 7000-75 mbarg		18
10.10	Install Meter		1
10.11	CV Device order/delivery		12
10.12	Install CV Device		1
10.13	22.5kVA Diesel Generator & UPS Order/Delivery		12
10.14	Install Diesel Generator & UPS		1
10.15	Install Site Electrical works		3
10.16	Install Site Mechanical works		2
10.17	Site Commissioning		1
10.18	Order/Delivery of 7-Tonne CNG Trailer		25
Tain Mains Pipeline and Preliminaries to Network Installation			
11.1	Site mobilisation period	Fulcrum Pipelines-Operations	13
11.2	NRSWA notices submitted		1
11.3	Traffic management agreed with local authority		5
11.4	Local communications with residents for route of construction		56
11.5	Procurement of materials		56
11.6	Install feeder main (2 Teams)		15
Yellow Mains and Services Installation Phase 1			
11.7	Phase 1- Install yellow mains (2 Teams)	Fulcrum Pipelines-Ops	5
11.8	Phase 1- Install services (2 Teams)		5
Yellow Mains and Services Installation Phase 2			
11.9	Phase 2- Install yellow mains (2 Teams)	Fulcrum Pipelines-Ops	5
11.10	Phase 2- Install services (2 Teams)		5
Yellow Mains and Services Installation Phase 3			
11.11	Phase 3- Install yellow mains (2 Teams)	Fulcrum Pipelines-Ops	5
11.12	Phase 3- Install services (2 Teams)		5
Yellow Mains and Services Installation Phase 4			
11.13	Phase 4- Install yellow mains (2 Teams)	Fulcrum Pipelines-Ops	5
11.14	Phase 4- Install services (2 Teams)		5
Yellow Mains and Services Installation Phase 5			
11.15	Phase 5- Install yellow mains (2 Teams)	Fulcrum Pipelines-Ops	5
11.16	Phase 5- Install services (2 Teams)		5
Yellow Mains and Services Installation Phase 6			
11.17	Phase 6- Install final yellow mains (2 Teams)	Fulcrum Pipelines-Ops	3
11.18	Phase 6- Install final services (2 Teams)		7
Trial of Hybrid Heat-Pumps			
12.1	Design of Trial	CNG Services Ltd. and Imperial College London	18
12.2	Planning of Trial		17
12.3	Installation of 45 units		27
12.4	Initial data review		26
12.5	Final data review & reporting		25
Knowledge Dissemination			
13.1	Create and maintain blog	Fulcrum Pipelines	41
13.2	Knowledge sharing events	CSL, FP, ICL, IGEM	7
13.3	Publish Reports		51



Appendix J: Project risk register

Ref No.	Risk Category	Risk Description	Possible Consequence(s)	Initial Risk Probability (P)	Initial Risk Impact (I)	Initial Risk Exposure (I x P)	Existing Mitigation Measures	Future Mitigation Strategy	Residual Risk Probability (P)	Residual Risk Impact (I)	Residual Risk Exposure (I x P)
General											
1	Health and Safety	Failure to comply with Health and Safety legislation leading to a significant incident	Potential injury to workers, prosecution and/or project failure	3	5	H	Experienced and competent teams familiar with legislation. H&S risk register under development.	Complete and maintain separate H&S risk register	1	5	L
2	Environmental	Environmental impact of construction; possibility of an environmental incident due to construction activities	Prosecution, high clean-up costs, damage to the local environment	3	4	H	Fulcrum Pipelines is an ISO 14001 compliant company. Use experienced and competent teams and contractors.	Complete and maintain separate environmental risk register	1	4	L
3	Commercial	Delays in agreeing cooperation agreement between all parties	Project Delayed	2	3	M	MoU agreed between bid partners	Negotiate as early as possible. Schedule of agreements will be identified and planned for.	1	2	L
4	Commercial	Failure to obtain Council commitment/ low demand results in an uneconomic project	Project becomes uneconomic	3	5	H	Strong focus on gas price. Albyn Housing Society very supportive. Close process of engagement has commenced with Council.	Work with Council to support their analysis of the project alongside other options prior to Council decision	2	5	H
5	Commercial	Unable to secure viable commercial arrangement with gas supplier	Delay / delivered price risk	2	3	M	Initial market testing completed	Search for a supplier as soon as possible. Complete framework discussions.	1	3	L
6	Design	Changes to design fundamentals after commencement	Increased costs, delays to program, possible need to upsize pipes already installed.	3	2	M	Design has gone through a verification process. Phased approach to network development makes risk less likely.	Planned liaison with potential customers, agree milestones to lock down design before commencement.	1	2	L
7	Design	IGEM standards not completed on time	Project Delayed	3	3	M	IGEM supportive and have bought into programme		2	3	M
8	Financial	Insufficient funding from local authority / housing association	Project becomes uneconomic	2	5	H	Building close relationships. Support to project consistent with their policies	Potential from other funding sources downstream of the meter, identified in Appendix L.	1	4	L
9	Financial	Fluctuation in the price of alternative fuels reducing the viability of the conversion for end users	Project becomes uneconomic	3	3	M	Fundamental focus on keeping delivered gas price down	Market other benefits of gas	3	2	M
10	Financial	Subcontractor rates higher than budgeted costs due to inflation	Project becomes uneconomic	2	3	M	Using quoted and market tested cost		1	2	L
11	Financial	Cost increase due to exchange rate fluctuations	Project becomes uneconomic	2	2	L		Source from UK if possible	2	1	L
12	Financial	CNG/Glenmorangie Distillery project not approved	Project becomes uneconomic	2	5	H	Advanced stage of discussions. Received a letter of support	Strong stakeholder engagement going forward	1	5	L
13	Gas Supply	Gas supply to distillery/Tain is limited either by the amount of gas available by trailer or by PRS capacity due to higher than expected uptake	Turn away customers or interrupt Glenmorangie more often	2	2	L	Developing project in tranches focusing on social housing area.	Modelling of supply shows that even in an emergency, gas may be supplied from alternative sources (e.g.Leyland) at peak domestic and I&C loads, with a disruption to distillery supply. Correct load assessments in the planning stage with associated pipe sizing and delivery scheduling. Extra 7-tonne CNG Storage Trailer. Potential to invest in more capacity.	1	2	L
14	Project Management	Failure to achieve project deliverables results in a funding return request from Ofgem	Adverse financial impact on partners	2	5	H	Realistic programme agreed. Committed project partners and supportive RSLs	Good programme management and reporting	1	4	L
15	Project Schedule	Delayed delivery of equipment	Equipment is delivered behind schedule	2	2	L	Potential option to temporarily switch to an alternative filling facility at Leyland or Crewe.	New filling stations, one nearby at Lybster providing potential supply, one to be built in the Scottish Highlands.	2	1	L
16	Project Schedule	Poor coordination between parties leading to gaps or duplication in scope	Increased costs and potential for delay	3	3	M	Good partner relations. MoU obtained.	Co-operation agreement. Good programme management and reporting	2	3	M

Ref No.	Risk Category	Risk Description	Possible Consequence(s)	Initial Risk Probability (P)	Initial Risk Impact (I)	Initial Risk Exposure (I x P)	Existing Mitigation Measures	Future Mitigation Strategy	Residual Risk Probability (P)	Residual Risk Impact (I)	Residual Risk Exposure (I x P)
17	Regulatory	Failure to agree regulatory framework developments	Project cancelled	3	5	H	Ofgem discussions initiated. Proposals developed and included in submission	Recommence discussions as soon as possible	2	5	H
Fordoun Mother Station											
18	Gas Supply	Damage is caused to the station, either through vandalism or an accident, preventing the CNG Trailers from filling for a period of time.	Slowed or no flow to any CNG Trailers, hence no supply to distillery/Tain from Fordoun.	2	3	M	CCTV and 2.4m high palisade fencing surrounding equipment. Fencing also provided around entire site. Glenmorangie supply interruptible. Potential option to temporarily switch to an alternative filling facility at Leyland or Crewe. Insurance in place.	New filling stations, one nearby at Lybster providing potential supply, one to be built in the Scottish Highlands. Using NIC funding to purchase a backup 7-tonne trailer for use as a mobile storage unit.	1	2	L
19	Gas Supply	Force Majeure events, e.g. Heavy Snowfall at Fordoun CNG Station	Snow could slow/prevent trailer filling at Fordoun.	3	2	M	Glenmorangie Supply Interruptible. Potential option to temporarily switch to an alternative filling facility at Leyland or Crewe.	Potential contract with local contractors to remove snow in the event of heavy snowfall. New filling stations, one nearby at Lybster providing potential supply, one to be built in the Scottish Highlands. Modelling of alternative supply suggests that Tain peak demand can be satisfied with supply from, for example, Leyland filling station, with the distillery's gas supply interrupted. Using NIC funding to purchase a backup 7-tonne trailer for use as a mobile storage unit.	2	2	L
20	Gas Supply	Electricity supply interrupted: an electrical fault in the nearby grid causes no supply to Fordoun station's equipment.	No electricity to Compressors/Chillers/Dispensers. Hence no flow to CNG Trailers and no supply to distillery/Tain from Fordoun.	2	3	M	Glenmorangie Supply Interruptible. Potential option to temporarily switch to an alternative filling facility at Leyland or Crewe.	New filling stations, one nearby at Lybster providing potential supply, one to be built in the Scottish Highlands. Using NIC funding to purchase a backup 7-tonne trailer for use as a mobile storage unit and install a diesel generator and UPS onsite to provide electricity in the result of power supply failure.	2	1	L
21	Gas Supply	Plant equipment breaks down or fails in such a way that gas is not supplied to fill CNG Trailers	Unable to fill CNG Trailers, hence no supply to distillery/Tain from Fordoun	2	2	L	Glenmorangie Supply Interruptible. Potential option to temporarily switch to an alternative filling facility at Leyland or Crewe. Equipment at Fordoun designed to have 100% redundancy e.g. two compressors running in duty/standby operation	New filling stations, one nearby at Lybster providing potential supply, one to be built in the Scottish Highlands. Using NIC funding to purchase a backup 7-tonne trailer for use as a mobile storage unit.	1	1	L
22	Gas Supply	HSE don't approve MAPD and Safety Case for Fordoun	Site cannot operate	2	5	H	Draft documents in place. Discussions with HSE underway.	Appropriate expertise to be identified to ensure HSE approval.	1	5	L
23	General/Other	Fordoun project not approved and thus the CNG mother station isn't constructed	Inability to fill CNG Trailers for supply to Tain	2	5	H	Planning consent in place. Significant funds committed.	New filling stations, one nearby at Lybster providing potential supply, one to be built in the Scottish Highlands.	1	5	L
Logistics											
24	Gas Supply	Trailer breakdown or accident	Trailer not operational	2	2	L	Trailers have ADR/TEPD. Trailer design approved by Air Liquide.	New filling stations, one nearby at Lybster providing potential supply, one to be built in the Scottish Highlands. Using NIC funding to purchase a backup 7-tonne trailer for use as a mobile storage unit	1	2	L
25	Gas Supply	Heavy Snowfall/Accidents blocks roads	Trailer travel time from Fordoun to Tain increased.	3	3	M	Can potentially reroute trailers if necessary. Glenmorangie Supply Interruptible. Potential option to temporarily switch to an alternative filling facility at Leyland or Crewe (trailers using different roads for supply).	Ability to Interrupt other Distilleries and use their trailers to supply gas to Tain. Using NIC funding to purchase a backup 7-tonne trailer as a mobile storage unit.	2	2	L
Tain / CNG Daughter Station											
26	Design	Hazardous Area Zones - Installing non-certified equipment in a hazardous area	Range of possible consequences, including severe safety risks	1	4	L	Layout drawings provided showing locations of certified and non certified equipment based on ATEX zonal layout drawing. Only approved suppliers are used to provide safe and good quality materials. Use competent staff.		1	1	L
27	Design	HP pipework failure, anywhere from trailer through to meter.	Explosion and or/rupture of pipelines in close proximity to workers or daughter station assets	1	5	L	Pipework designed and installed to UK and EU regs using competant people and detailed RAMS		1	5	L

Ref No.	Risk Category	Risk Description	Possible Consequence(s)	Initial Risk Probability (P)	Initial Risk Impact (I)	Initial Risk Exposure (I x P)	Existing Mitigation Measures	Future Mitigation Strategy	Residual Risk Probability (P)	Residual Risk Impact (I)	Residual Risk Exposure (I x P)
28	Gas Supply	Damage is caused to the station, either through vandalism or an accident, preventing the CNG Trailers from filling for a period of time.	Slowed or no supply to distillery/Tain	2	5	H	2.4m high palisade fencing surrounding equipment. Fencing also provided around entire site. Glenmorangie Supply Interruptible	Potential hiring of a specialist support engineer, local enough that should an issue occur, will be onsite in sufficient time to prevent noticable downtime. CCTV to be used as a deterrent	1	5	L
29	Gas Supply	Hazardous Substances Consent is not obtained for the daughter station site	No more than 15 tonnes of CNG can be stored onsite	2	4	M	Competent resouce identified to support HSC application. Early commencement of engagement	Other logistical options can be considered	1	3	L
30	Gas Supply	Electricity supply interrupted: An electrical fault in the nearby grid causes no supply to the daughter station's equipment.	No electricity supply to equipment. Hence no flow from CNG Trailers and no supply to distillery/Tain.	2	4	M		Installation of a small diesel generator and UPS onsite to provide electricity in the result of power supply failure.	2	1	L
31	Project Schedule	Poor Weather Conditions (e.g. Heavy Snowfall)	Following tasks delayed, potential of missed deadlines	2	2	L	Customers not due for gas supply intil Q3 2019	Build contingency into a detailed plan	2	1	L
32	Project Schedule	A longer time than anticipated is taken to obtain GL5 for the IP pipework	Following tasks delayed, potential of missed deadlines	2	2	L	Early engagement. Competant resources identified to secure GL5 approval		1	2	L
33	Regulatory	CSL HSE safety case not accepted	Project cancelled	3	5	H	Appropriate expertise to be identified to ensure HSE approval. Initial HSE discussion has taken place.	Engage with HSE with a detailed plan of the project and a proposed safety case with amendments.	1	5	L
Fulcrum iGT Network											
33	Construction	Traffic Management requirements exceed assumptions: a high number of road closures required. Longer lead time from local authority	Disruption to the planned program, considerable disruption to the local community.	3	2	M	Serve notice under New roads and streetworks act, Local engagement with Highways authority and other stakeholders		1	2	L
34	Construction	Exceptionally difficult ground conditions such as rock or running sand or high water tables	Disruption to program, additional costs for specialist excavation techniques and or dewatering equipment	2	2	L	Pre-survey pipeline route before final designs are agreed		1	2	L
35	Construction	Delay and disruption to programme due to mature utilties area; the preferred pipe route may be congested by other utilities and underground plant	Damage caused to underground plant and utilities, risk of serious injury to personnel, disruption to local community. Program delay.	4	2	M	Detailed utility plans and location on site, trial holes and safe digging techniques		2	2	L
36	Design	Unforseen special crossings; engineering difficulties may be encountered on the proposed route of the pipe to negotiate unknown objects that will need to be crossed.	Delays to program, increased costs to negotiate the object, Re-route of planned pipe work	2	2	L	Pre-survey pipeline route before final designs are agreed		1	2	L
37	Design	DCC data communication process unavailable	Delay to receipt of daily data	3	3	M	Engagement with DCC commenced. Funding for any future development requested	Manual meter readings for interim period if necessary	2	2	L
38	Financial	Captial costs exceeded	Advserse financial impact	2	4	M	Costings developed on basis of significant experience using professional skill and expertise	Market testing and strong project management	2	2	L
39	Project Schedule	Exceptional winter conditions restricting access and operation on site leading to a cost increase and programme delay.	Unable to attend site due to heavy snow, delays in program, unable to joint pipe due to low tempratures	4	2	M	Program installation to avoid winter periods plan construction that is no weather or temperature dependent	Accomodate teams in hotels, provide work tents to protect joint process from inclement weather	2	1	L
40	Regulatory	Inability to fulfil statuatory response times	Breach of Licence conditions	1	5	L	Existing emergency contract available	Develop a more local arrangement with a suitable organisation	1	3	L
41	Regulatory	Fulcrum HSE safety case not accepted	Project cancelled	3	5	H	Appropriate expertise to be identified to ensure HSE approval.	Engage with HSE with a detailed plan of the project and a proposed safety case with amendments.	1	5	L

Appendix K: Data verification process

All of the data in this submission has been verified by someone other than the data's originator. Table K1 documents this process.

Table K1 – Data verification: data areas, originators and verifiers

Data Area	**Originator**	Verifier
Environmental Benefits		
Housing stock assumptions	Simon Griew	Nilay Shah
Customer take-up estimates	Simon Griew	Nilay Shah
Fuel efficiency assumptions	Nilay Shah	Gonzalo Bustos-Turu
Insulation assumptions	Nilay Shah	Gonzalo Bustos-Turu
Demand estimates	Nilay Shah	Gonzalo Bustos-Turu
Gas supply profiles	Simon Griew	John Baldwin
Carbon intensity estimates	Simon Griew	John Baldwin
Emissions estimates	Simon Griew	Nilay Shah
Wider roll-out assumptions	Simon Griew	John Baldwin
Network capacity benefits	Simon Griew	John Baldwin
Technical data / assumptions		
Trailer logistics model	Matthew Paget	John Baldwin
CNG Services technical assumptions	Matthew Paget/Nick King	John Baldwin
Fulcrum Pipelines technical assumptions	Jonathan Windle	Paul Leighton
Cost estimates		
CNG Services derived costs	Matthew Paget/Nick King	John Baldwin
Fulcrum Pipelines derived costs	Danny Buxton	Carly Gilchrist
Hybrid heating systems	Nilay Shah	Ian Atkinson
Regulatory/commercial framework development	Tim Davis	Simon Griew
Technical standards	Nick King	Simon Griew
Bid preparation	ALL	Ian Atkinson
Financial benefits		
Pricing assumptions	Simon Griew	Ian Atkinson
Alternative fuel price assumptions	Simon Griew	Ian Atkinson
Base Case cost estimates	Simon Griew	Ian Atkinson
Method cost estimate	Simon Griew	Ian Atkinson
Financial benefit estimates	Simon Griew	Ian Atkinson

Appendix L: Summary of financial support schemes for householders and businesses installing renewables and energy efficiency measures (as at 19th July 2017)

This table contains a summary of information provided by the Energy Savings Trust, covering all the national schemes that they are aware of. There are also local schemes which arise on an ad hoc basis. In addition to the schemes below, Public Works Loan Board (PWLB) can provide loan funding for Local Authorities to carry out capital infrastructure projects.

Scheme name	Measures supported	Sectors supported	Description	Funder	Managed by:	End date
Home Energy Efficiency Programmes for Scotland Area Based Schemes	Energy efficiency (Usually solid wall and cavity wall and roof insulation measures but has supported a range of other measures, where agreed by the LA and Scottish Government).	Domestic owner occupiers Private domestic tenants and private landlords.	Measures identified and targeted in specific areas or types of property by local authorities, with grants in 2017/18 of up to £6,500 for flats, £7,000 for mid terrace and £7,500 for other built forms, available to each household Measures are supported through ECO as well, where possible. http://www.energysavingtrust.org.uk/area-based-schemes	Scottish Government	Scottish Local authorities (often route enquiries through Home Energy Scotland)	Currently open
Scottish Energy Efficiency Programmes (SEEPs)	Community heating/energy efficiency /renewables	LAs partnering domestic and non-domestic sectors.	SEEP will provide an offer of support to all buildings in Scotland – domestic and non-domestic – to improve their energy efficiency rating. Due to be in place 1 April 2018. http://www.gov.scot/Topics/Business-Industry/Energy/Action/lowcarbon/LCITP/SEEP	Scottish Government	Local authorities	closed for new applications

Scheme name	Measures supported	Sectors supported	Description	Funder	Managed by:	End date
Home Energy Scotland loan	Energy efficiency measures and renewables, (from a specified list), and connection to renewably powered district heating.	Owner occupiers and certain registered private sector landlords in Scotland.	Interest free loan of up to £15,000 for installing a variety of measures, such as solid wall insulation, double glazing or a new boiler. Funding is also available for private sector landlords for up to 3 properties. The household must have loft and cavity wall insulation installed, where practicable. If installing energy efficiency improvements, applicants are currently eligible to receive a grant for 25% of the cost of their work, up to a maximum available for each improvement and an overall maximum of £3,750. Loan funding is available for the remaining cost, up to a maximum for each improvement. The repayment period varies based on the amount borrowed but those taking out higher value loans will be able to pay back over a period up to 12 years. http://www.energysavingtrust.org.uk/scotland/grants-loans/home-energy-scotland-loan	Scottish Government	Energy Saving Trust	Currently open, but cashback and loan separately subject to availability.

Scheme name	Measures supported	Sectors supported	Description	Funder	Managed by:	End date
HEEPS: Gas Infill Loan (through the Home Energy Scotland loan scheme)	Connection to gas mains and installation of gas central heating with a mains connection.	Owner occupiers and certain registered private sector landlords in Scotland.	Interest free loan funding for individuals of up to £5,000 to cover any gas connection and an additional £5,000 for associated heating installation costs (an admin fee is charged to applicants who complete works and claim their loan). The household must have loft and cavity wall insulation installed, where practicable. 25% cashback is also available towards those installing a gas central heating system, up to a maximum of £400. http://www.energysavingtrust.org.uk/scotland/grants-loans/home-energy-scotland-loan	Scottish Government	Energy Saving Trust	Currently open
HEEPS: ABS Loan scheme	Energy efficiency measures delivered through HEEPS: ABS and associated repairs	Owner occupiers and certain private sector landlords	Up to £5,000 interest free loan funding available to meet householder contributions for energy efficiency measures delivered through HEEPS: ABS and up to £5,000 for approved repairs necessary to allow measures to be installed. An admin fee is applied to all paid loans. Repayments are made over a maximum of 10 years.	Scottish Government	Energy Saving Trust	Currently open

Scheme name	Measures supported	Sectors supported	Description	Funder	Managed by:	End date
HEEPS: Warmer Homes Scotland Loan scheme (through HEEPS: Loan scheme)	Energy efficiency measures delivered through Warmer Homes Scotland	Owner occupiers and certain private sector landlords	Interest free loans of up to £4,500 for homeowners or landlords whose properties are in receipt of an offer of support from the Warmer Homes Scotland Programme managed by Warmworks and who need further assistance to help pay a contribution towards the work. An admin fee is applied to all paid loans. Repayments are made over a maximum of 8 years.	Scottish Government	Energy Saving Trust	Currently open
HEEPS Loan scheme for Registered Social Landlords	Energy efficiency, renewables and associated repairs (from a specified list based on ECO eligible measures).	RSLs	Interest free loans of between £30,000 and £1 million are available to housing associations and housing co-operatives to install energy saving measures with the aim of progressing properties towards the required Energy Efficiency Standard for Social Housing (EESSH) standard. Funding is also available for repairs or enabling work to allow eligible energy saving measures to go ahead. Repayments are made over 10 years. http://www.energysavingtrust.org.uk/scotland/grants-loans/heeps/heeps-loan-scheme-registered-social-landlords	Scottish Government	Energy Saving Trust	Currently open
Home Energy Efficiency Programmes for Scotland	Energy advice, benefits checks and tariff support	Householders in all tenures.	Home Energy Scotland assesses need of householders for energy, benefits and tariff advice and provides energy advice and refers to partners for tariff and benefits advice.	Scottish Government	Energy Saving Trust / Home Energy Scotland	Currently open

Scheme name	Measures supported	Sectors supported	Description	Funder	Managed by:	End date
Resource Efficient Scotland SME loan scheme	Energy efficiency and renewable measures, including by private sector landlords.	SMEs including private sector landlords	Interest free loan (5% if claiming RHI or FITs) funding from £1,000 to £100,000 to install energy efficiency measures and renewable technologies, available to SMEs including private sector landlords. http://www.energysavingtrust.org.uk/scotland/businesses-organisations/landlords http://www.resourceefficientscotland.com/financial-support-make-changes	Scottish Government	Resource Efficient Scotland and Energy Saving Trust	Currently available
Home Energy Efficiency Programmes for Scotland Equity Loan Pilot Scheme	Energy efficiency improvements and repairs to building fabric	Domestic owner occupiers and certain private sector landlords	Up to £40,000 based on equity on the property, repaid at point of sale of the house. Piloted in Glasgow, Perth and Kinross and Argyll and Bute local authorities. http://www.energysavingtrust.org.uk/scotland/grants-loans/heeps/heeps-equity-loan-scheme	Scottish Government	Energy Saving Trust	Currently open with pilot scheduled to continue until March 2018
Communities and Renewables Energy Scheme (CARES) pre-planning loans	Renewables	Community groups Charities Social housing providers Local authorities Rural businesses.	Grants to community groups of up to £10,000. Loans of up to £150,000 towards pre-planning costs for community renewables projects. Interest rate 10% with write-off facility available. http://www.localenergyscotland.org/cares	Scottish Government	Local Energy Scotland	Currently open

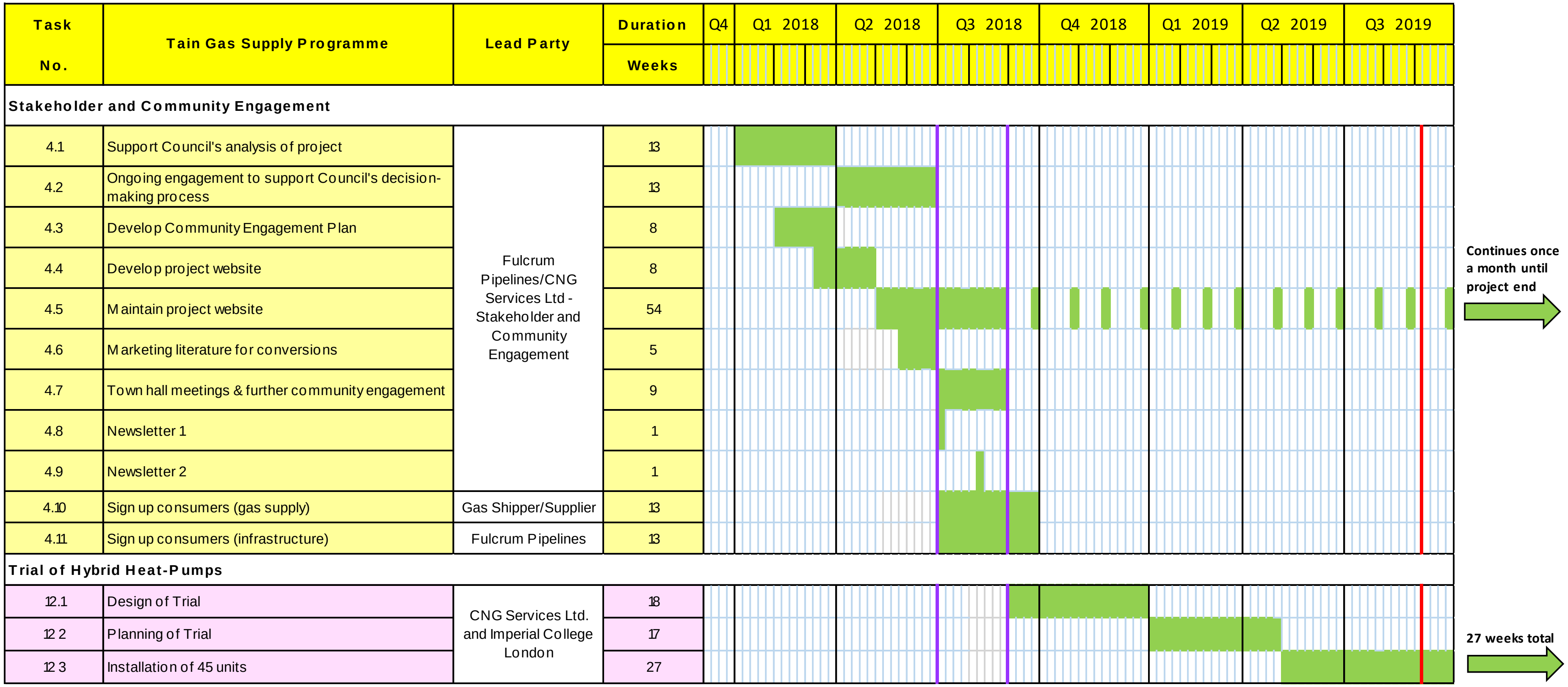
Scheme name	Measures supported	Sectors supported	Description	Funder	Managed by:	End date
(CARES) Infrastructure and Innovation Fund	Grant funding to investigate and develop projects that link local energy generation with local energy use, or projects that wish to develop innovative distribution and storage solutions	Various including community groups, registered charities, local authority, registered social landlord	Grant funding for research, feasibility and pilots of up to £70,000. Up to 100% available, match funding welcomed. http://www.localenergyscotland.org/iif	Scottish Government	Local Energy Scotland	Currently closed to new applications
(CARES) Local Energy Challenge Fund	Large scale low carbon demonstrator projects linking local energy generation to local demand. Phase 1 – feasibility and development support Phase 2 – capital funds	A consortium/ partnership consisting of at least two of from a wide-range of organisations including community group, local authority, registered social landlord, distribution network operator, or commercial organisation.	The Challenge Fund operates over two phases. The first (phase 1) provides feasibility and development support of up to £25k for applicants developing project proposals. The second phase (phase 2) provides capital funding of between £500k - £6m to deliver projects. Only projects that are successful in obtaining phase 1 support can submit an application for phase 2. http://www.localenergyscotland.org/challenge	Scottish Government	Local Energy Scotland	Closed to new applications for 2016-17. Further rounds tbc.

Scheme name	Measures supported	Sectors supported	Description	Funder	Managed by:	End date
Domestic Renewable Heat Incentive (RHI)	Domestic renewables (heat only)	Domestic owner occupiers Registered social landlords Private sector domestic landlords	Ongoing payments for 7 years for the renewable heat required for 20 years of space and/or water heating in a home	Department of Energy and Climate Change	Ofgem	Not stated
Renewable Heat Incentive (RHI) (non-domestic schemes)	Renewables (heat only)	Local Authorities Housing Associations SME's Community Groups	Ongoing payments (over 20 years) for renewable heat (including district heating) generated to supply more than one domestic property. https://www.ofgem.gov.uk/environmental-programmes/non-domestic-renewable-heat-incentive-rhi/eligibility-non-domestic-rhi https://www.gov.uk/government/news/non-domestic-rhi-events-and-roadshows	Department of Energy and Climate Change	Ofgem	Not stated
Help to Heat	Gas connections	All tenures of domestic housing	Gas connection subsidy for households that meet certain benefit criteria or live in bottom 20% of SIMD areas. Available where the connection is carried out by SGN, the default gas transporter in Scotland and sometimes through independent gas transporters as well. https://www.sgn.co.uk/helptoheat/	SGN (mandated by Ofgem)	SGN	Currently open
Low Carbon Infrastructure Transition Programme (LCITP)	Renewables /low carbon/district heating	Private, Public Community based low carbon projects	Development grant support (50% grants) to develop individual projects to investment ready status. http://www.gov.scot/Topics/Business-Industry/Energy/Action/lowcarbon/LCITP	Scottish Government	Scottish Government	Currently open.

Scheme name	Measures supported	Sectors supported	Description	Funder	Managed by:	End date
Warm Homes Fund (WHF)	Gas and low running cost heating installations	Social housing providers, local authorities and other organisations working in partnership with them, to address some of the issues affecting fuel poor households	A £150million fund administered by AWS incentivising the installation of affordable heating solutions in fuel poor households who do not use mains gas as their primary heating fuel. It is envisaged that this fund will be used to supplement local strategic plans and funds blended with local support. Scope expected to include support for new gas heating systems which provide space heating and domestic hot water. Will also include specific energy efficient/health related solutions – this may involve national or regional programmes which bring together relevant organisations and charities to promote energy efficiency and health related programmes in relation to fuel poverty. https://www.affordablewarmthsolutions.org.uk/warm-homes-fund/overview?utm_source=sendinblue&utm_campaign=The_Warm_Homes_Fund&utm_medium=email	National Grid and Community Interest Company, Affordable Warmth Solution	National Grid and Community Interest Company, Affordable Warmth Solution	Operating up to 2020. Deadline of current expressions of interest deadline is 31/7/17.

Appendix M: Customer engagement plan

This Appendix contains an extract of the project plan to highlight the activities associated with customer engagement in the pre-construction phase of the project, and the hybrid heating system trial.

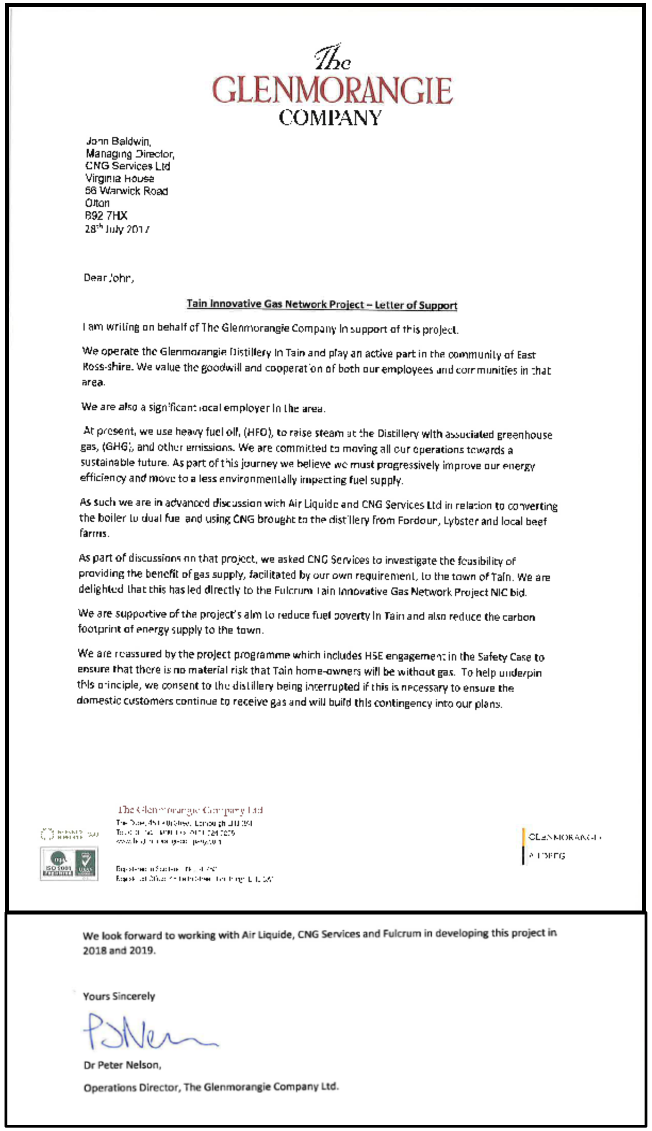


Task No.	Tain Gas Supply Programme	Lead Party	Duration Weeks
Stakeholder and Community Engagement			
4.1	Support Council's analysis of project	Fulcrum Pipelines/CNG Services Ltd - Stakeholder and Community Engagement	13
4.2	Ongoing engagement to support Council's decision-making process		13
4.3	Develop Community Engagement Plan		8
4.4	Develop project website		8
4.5	Maintain project website		54
4.6	Marketing literature for conversions		5
4.7	Town hall meetings & further community engagement		9
4.8	Newsletter 1		1
4.9	Newsletter 2		1
4.10	Sign up consumers (gas supply)	Gas Shipper/Supplier	13
4.11	Sign up consumers (infrastructure)	Fulcrum Pipelines	13
Trial of Hybrid Heat-Pumps			
12.1	Design of Trial	CNG Services Ltd. and Imperial College London	18
12 2	Planning of Trial		17
12 3	Installation of 45 units		27

Continues once a month until project end

27 weeks total

Appendix N: Letters of support



The
GLENMORANGIE
COMPANY

John Baldwin,
Managing Director,
CNG Services Ltd
Virginia House
56 Warwick Road
Olton
B92 7HX
28th July 2017

Dear John,

<u>Tain Innovative Gas Network Project – Letter of Support</u>

I am writing on behalf of The Glenmorangie Company in support of this project.

We operate the Glenmorangie Distillery in Tain and play an active part in the community of East Ross-shire. We value the goodwill and cooperation of both our employees and communities in that area.

We are also a significant local employer in the area.

At present, we use heavy fuel oil, (HFO), to raise steam at the Distillery with associated greenhouse gas, (GHG), and other emissions. We are committed to moving all our operations towards a sustainable future. As part of this journey we believe we must progressively improve our energy efficiency and move to a less environmentally impacting fuel supply.

As such we are in advanced discussion with Air Liquide and CNG Services Ltd in relation to converting the boiler to dual fuel and using CNG brought to the distillery from Fordour, Lybster and local beef farms.

As part of discussions on that project, we asked CNG Services to investigate the feasibility of providing the benefit of gas supply, facilitated by our own requirement, to the town of Tain. We are delighted that this has led directly to the Fulcrum Tain Innovative Gas Network Project NIC bid.

We are supportive of the project's aim to reduce fuel poverty in Tain and also reduce the carbon footprint of energy supply to the town.

We are reassured by the project programme which includes HSE engagement in the Safety Case to ensure that there is no material risk that Tain home-owners will be without gas. To help underpin this principle, we consent to the distillery being interrupted if this is necessary to ensure the domestic customers continue to receive gas and will build this contingency into our plans.

The Glenmorangie Company Ltd

We look forward to working with Air Liquide, CNG Services and Fulcrum in developing this project in 2018 and 2019.

Yours Sincerely

Dr Peter Nelson,

Operations Director, The Glenmorangie Company Ltd.

The Highland Council
Comhairle na Gàidhealtachd

John Baldwin
Managing Director
CNG Services Ltd
56 Warwick Rd
Solihull
B92 7HX

Please ask for: Eddie Boyd
Direct Dial: 01463 255270
E-mail: eddie.boyd@highland.gov.uk
Date: 18 October 2017

Dear Mr Baldwin

PROVISION OF CNG GAS SUPPLIES TO TAIN

Further to our discussions on your proposals for the delivery of compressed natural gas (CNG) to the Royal Burgh of Tain.

This is a stimulating and appropriate project that could provide the basis for a transformational change to the town. I can see the benefits of a demonstration of the concept and value of the extension to the distillery project that could deliver infrastructure on an economic basis. I would encourage accelerated innovation in the development with biogas and hydrogen being considered for inclusion at an early stage.

There are high levels of fuel poverty in the area and the project could have a significant impact on this under the right regulatory framework.

The Council do need to ensure that the best overall option for the community is achieved and we are very eager to work closely with you to ensure that it can determine and deliver a project that will bring all the expected value and environmental improvements needed to meet the emerging policy requirements.

Yours sincerely,

Eddie Boyd, Energy & Sustainability Manager

Director of Development & Infrastructure: J Stuart Black, MA (Hons), PhD
Energy & Sustainability Section, Development & Infrastructure Service,
The Highland Council, North Tower, Inverness Castle, INVERNESS, IV2 3EG.
Tel: (01349) 886606 **E-mail:** energy-advice@highland.gov.uk **Website:** www.highland.gov.uk

albyn
Housing Society
building homes...supporting communities

Tain gas opportunity

13th July 2017
John Baldwin
Manaignin Director
CNG Services Ltd

Dear John

Tain Gas Opportunity

Albyn Housing Society is very excited to support this innovative project to provide a gas supply to Tain. We have circa 135 properties in Tain which will require their heating upgraded over the next 3-4 years. The opportunity to connect into an affordable gas supply will support both our energy efficiency strategy and most importantly support our fuel poverty agenda.

We look forward to hearing of progress being made towards delivering the necessary infrastructure.

Yours Sincerely

Helen Cameron

Helen Cameron
Programme Coordinator
Direct Dial: 01349 855957
Email: helen.cameron@albynhousing.org.uk

☐ Albyn Housing Society Limited Registered Office: 98-104 High Street, Invergordon, Ross-shire IV18 0DL
Tel: 01349 852976 Fax: 01349 [illegible] email: office@albynhousing.org.uk

☐ Inverness Office: 68 MacLennan Crescent, Inverness, IV3 8DN
Tel: 01463 712618 Fax: 01463 242590 www.albynhousing.org.uk

HIE
Highlands and Islands Enterprise
Iomairt na Gàidhealtachd 's nan Eilean

Mr. John Baldwin
CNG Services Ltd
Virginia House
56 Warwick Road
Olton
B92 7HX

Date: 18th July 2017

Dear John

I write to communicate that we endorse the efforts of CNG and Glenmorangie to switch to CNG at the distillers operations in Tain. The information that has been provided to us states that the change from oil to compressed gas is likely to lower the plant's carbon footprint and also contribute to improved efficiency.

We also welcome the possibility that the community of Tain may have the choice of compressed gas as an alternative to deliver this new (to Tain) source of home energy and the participation of CNG with a community energy provider. The prospect of using the Lybster gas field may also bring lower transport costs and also provide the infrastructure for possible future use of local or Scottish generated bio-gas once the Lybster field is exhausted.

This letter is not an offer of financial assistance. Any assistance from Highlands and Islands Enterprise is provided only after formal application, approval and signature of a formal undertaking.

Yours sincerely

James Gibbs

James Gibbs

James Gibbs

Area Manager – Inner Moray Firth |
Manaidsear Sgìre - Linne Mhoireibh a-staigh

Highlands and Islands Enterprise, An Lòchran, 10 Inverness Campus, Inverness, IV2 5NA, Scotland
Iomairt na Gàidhealtachd 's nan Eilean, An Lòchran, 10 Àrainn Inbhir Nis, Inbhir Nis, IV2 5NA, Alba
T +44 (0)1463 245245 E info@hient.co.uk W www.hie.co.uk

Cadent Gas Limited
Brick Kiln Street, Hinckley
Leicestershire LE10 0NA
cadentgas.com

David Parkin
Director Safety & Network Strategy

David.Parkin@cadentgas.com
Direct Tel +44 (0)1455 893193

Cadent
Your Gas Network

Reference
Tain

Date
26th July 2017

Mr John Baldwin
Managing Director
CNG Services Ltd
Virginia house,
56 Warwick Road,
Olton,
Solihull
B92 7HX

Dear John,

Thank you for forwarding details of the Tain Innovative Gas Grid NIC project.

Cadent is pleased to support this project, which offers an innovative approach to the connection of presently off-grid communities to a natural gas supply. With our BioSNG and HyDeploy projects ongoing, we are interested in the potential for standalone networks like this to accommodate increasing levels of low carbon gas in the future. Cadent believes that bioenergy, and in particular renewable gas, can make a significant contribution to meeting 2050 climate change targets, including through the decarbonisation of heat. We can also see fuel poverty benefits in off-grid towns.

Constructing a small distribution network from scratch offers the prospect of a hydrogen-ready gas grid, and I understand that our respective teams have been liaising to ensure that the issues under investigation in HyDeploy are fully understood in the development of the Tain project.

We are also interested in your proposed trial of hybrid heating systems, which will complement other heat pump studies (such as FREEDOM) and provide valuable learning in relation to potential multi-vector system configurations.

Heat decarbonisation is an imperative for the energy industry but the direction of travel remains uncertain and it is important that different ideas are tried to develop options, we are pleased to offer support to the Tain project as part of moving the industry forward.

Good luck with your submission, and I will look forward to hearing about the project as it develops.

Yours sincerely,

David Parkin

David Parkin
Director Safety & Network Strategy

Cadent Gas Limited

National Gas Emergency Service
0800 111 999* (24hrs)
*Calls will be recorded and may be monitored

Page 1 of 2

Local Energy Scotland
Energy Saving Trust
Ocean Point 1
94 Ocean Drive
Edinburgh, EH6 6JH

The Scottish Government's Community and Renewable Energy Scheme (CARES) is delivered by Local Energy Scotland.

LOCAL ENERGY SCOTLAND

Mr John Baldwin
CNG Services Ltd
Managing Director
Virginia House
56 Warwick Road
Olton,
West Midlands B92 7GX

21st July 2017

Dear John

Thank you for sending the overview for the Tain Innovative Gas proposal which you are preparing and submitting to the Ofgem as part of their Gas Network Innovation Competition .This letter is to confirm our interest in and ssupport for this proposal.

Local Energy Scotland has a particular interest in local and community scale energy projects in the national setting. Our primary role is to administrate and manage the Community and Renewable Energy Scheme (CARES) established by the Scottish Government to encourage local and community ownership of renewable energy across Scotland. The Scottish Government have ambitious new targets for 1GW of community and locally owned renewables by 2020 and at least half of newly consented renewable energy projects will have an element of shared ownership by 2020.

The project shares our belief for maximising the community benefit while minimising environmental impact, and we would be keen to support this project that aims to alleviate fuel poverty in the local Tain area and other potential communities across Scotland.

Members from the Local Energy Scotland team would look to support the proposed initiative is definitely something we are keen to support. Good luck with you application

Yours sincerely,

Chris Morris

Local Energy Scotland Manager

LOCALENERGYSCOTLAND.ORG
0808 808 2288
FUNDED BY THE SCOTTISH GOVERNMENT

The Local Energy Scotland consortium members are: Changeworks, Energy Agency, Energy Saving Trust, SCARF and the Wise Group.

Greener Scotland
Scottish Government

IGas
Energy
incorporating
DART ENERGY

John Baldwin
CNG Services Ltd
Virginia House
56 Warwick Road
Olton
Solihull
West Midlands
B92 7HX

Dear John,

Many thanks for sharing with us your proposals to install a new, standalone CNG and biomethane gas network to serve the Highlands town of Tain.

As you know, we own and operate the Lybster well site which is located around 45 miles further up the coast, just south of Wick. As you will also be aware, we received permission in February of this year from Highland Council to recover the natural gas that is produced from the well and store it as compressed natural gas for transportation.

This makes us extremely well placed, both geographically and logistically, to support this project and, if required, supply some of the CNG for the residents of Tain.

Using gas for heating provides significant savings over the use of electricity and, as your preliminary research suggests, savings could reach as high as £700 pa for some of Tain's households. Beyond being able to provide CNG, we are excited by the potential this project offers to deliver several real and tangible benefits for the residents of Tain, not least of which is cheaper fuel and reduce fuel poverty in the town. This is over and above the environmental benefit of switching some residents from oil or coal heating to gas heating due to the relatively low emissions of CNG.

Furthermore, we would be proud to be involved in such an innovative project that has the potential to be rolled out elsewhere and reduce incidents of fuel poverty across the country.

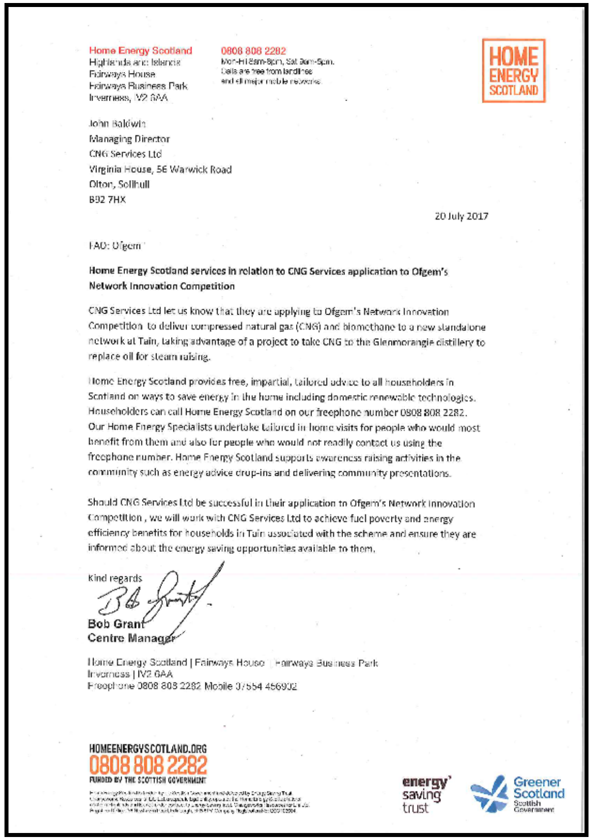
We look forward to the opportunity of working with CNG Services and Glenmorangie on this project and developing the approach to provide this solution to other "off grid" towns across Scotland and beyond.

Yours sincerely,

John. M. Blaymires.

John Blaymires
Chief Operating Officer

IGas Energy PLC, [illegible] Tel: 020 7993 9901 www.igasplc.com



Home Energy Scotland
Highlands and Islands
Fairways House
Fairways Business Park
Inverness, IV2 6AA

0808 808 2282
Mon-Fri 8am-8pm, Sat 9am-5pm.
Calls are free from landlines
and all major mobile networks.

HOME ENERGY SCOTLAND

John Baldwin
Managing Director
CNG Services Ltd
Virginia House, 56 Warwick Road
Olton, Solihull
B92 7HX

20 July 2017

FAO: Ofgem

Home Energy Scotland services in relation to CNG Services application to Ofgem's Network Innovation Competition

CNG Services Ltd let us know that they are applying to Ofgem's Network Innovation Competition to deliver compressed natural gas (CNG) and biomethane to a new standalone network at Tain, taking advantage of a project to take CNG to the Glenmorangie distillery to replace oil for steam raising.

Home Energy Scotland provides free, impartial, tailored advice to all householders in Scotland on ways to save energy in the home including domestic renewable technologies. Householders can call Home Energy Scotland on our freephone number 0808 808 2282. Our Home Energy Specialists undertake tailored in-home visits for people who would most benefit from them and also for people who would not readily contact us using the freephone number. Home Energy Scotland supports awareness raising activities in the community such as energy advice drop-ins and delivering community presentations.

Should CNG Services Ltd be successful in their application to Ofgem's Network Innovation Competition , we will work with CNG Services Ltd to achieve fuel poverty and energy efficiency benefits for households in Tain associated with the scheme and ensure they are informed about the energy saving opportunities available to them.

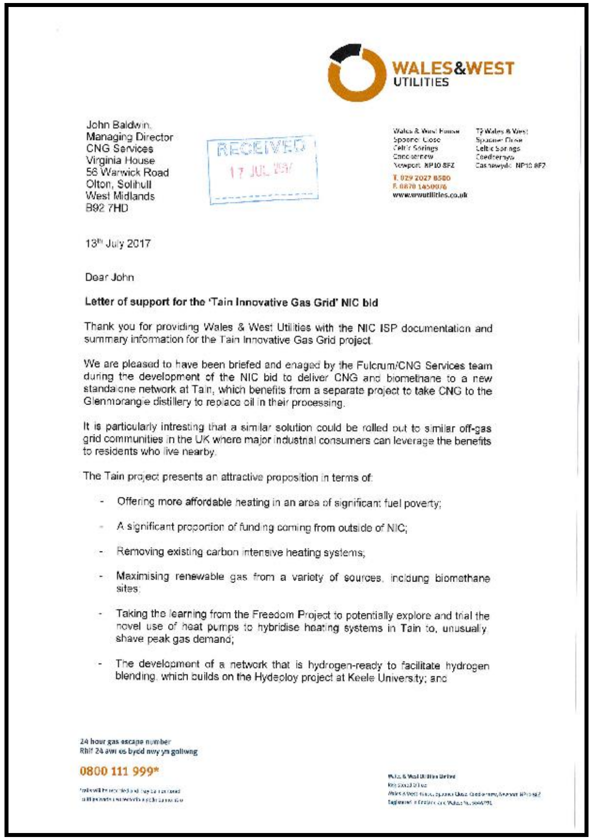
Kind regards

Bob Grant
Centre Manager

Home Energy Scotland | Fairways House | Fairways Business Park
Inverness | IV2 6AA
Freephone 0808 808 2282 Mobile 07554 456902

HOMEENERGYSCOTLAND.ORG
0808 808 2282
FUNDED BY THE SCOTTISH GOVERNMENT

energy saving trust
Greener Scotland Scottish Government



WALES&WEST UTILITIES

John Baldwin,
Managing Director
CNG Services
Virginia House
56 Warwick Road
Olton, Solihull
West Midlands
B92 7HD

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17 JUL 2017

Wales & West House
Spooner Close
Celtic Springs
Coedkernew
Newport NP10 8FZ

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Spooner Close
Celtic Springs
Coedkernew
Casnewydd NP10 8FZ

T. 029 2027 8500
F. 0870 1450076
www.wwutilities.co.uk

13th July 2017

Dear John

Letter of support for the 'Tain Innovative Gas Grid' NIC bid

Thank you for providing Wales & West Utilities with the NIC ISP documentation and summary information for the Tain Innovative Gas Grid project.

We are pleased to have been briefed and enaged by the Fulcrum/CNG Services team during the development of the NIC bid to deliver CNG and biomethane to a new standalone network at Tain, which benefits from a separate project to take CNG to the Glenmorangie distillery to replace oil in their processing.

It is particularly intresting that a similar solution could be rolled out to similar off-gas grid communities in the UK where major industrial consumers can leverage the benefits to residents who live nearby.

The Tain project presents an attractive proposition in terms of:

- Offering more affordable heating in an area of significant fuel poverty;
- A significant proportion of funding coming from outside of NIC;
- Removing existing carbon intensive heating systems;
- Maximising renewable gas from a variety of sources, incldung biomethane sites;
- Taking the learning from the Freedom Project to potentially explore and trial the novel use of heat pumps to hybridise heating systems in Tain to, unusually shave peak gas demand;
- The development of a network that is hydrogen-ready to facilitate hydrogen blending, which builds on the Hydeploy project at Keele University; and

24 hour gas escape number
Rhif 24 awr os bydd nwy yn gollwng

0800 111 999*

SGN

SGN
St Lawrence House
Station Approach
Horley, Surrey
RH6 9HJ

John Baldwin
Managing Director
CNG Services
Virginia House
56 Warwick Road
Olton, Solihull
West Midlands
B92 7HD

21 July 2017

Dear John,

Letter of support for the 'Tain Innovative Gas Grid' NIC bid

Thank you for providing SGN with the NIC ISP documentation and summary information for the Tain Innovative Gas Grid project.

We are pleased to have been engaged by the Fulcrum/CNG Services team during the development of the NIC bid to deliver CNG and biomethane to a new standalone network at Tain, which benefits from a separate project to take CNG to the Glenmorangie distillery to replace oil in their processing.

Hopefully the supporting information we have provided in relation to the 'Opening up the Gas Market' project, regulatory models, customer numbers, demand profiles and storage in the SIUs proves helpful.

We are supportive of extending gas infrastructure to support economic development, transitioning to a lower carbon economy and providing domestic customers with affordable energy.

We believe gas based solutions could be rolled out to similar off-gas grid communities in Scotland and the rest of the UK, both where major industrial consumers can leverage the benefits to residents who live nearby, and reciprocally, where the presence of a gas network stimulates economic development.

We are also supportive of the engagement with the Institution of Gas Engineers & Managers (IGEM) in developing new technical standards for the delivery of this solution, which will support knowledge dissemination.

Good luck with the bid.

Yours sincerely,

Simon Reilly

Simon Reilly
Commercial Director & Deputy CFO
SGN

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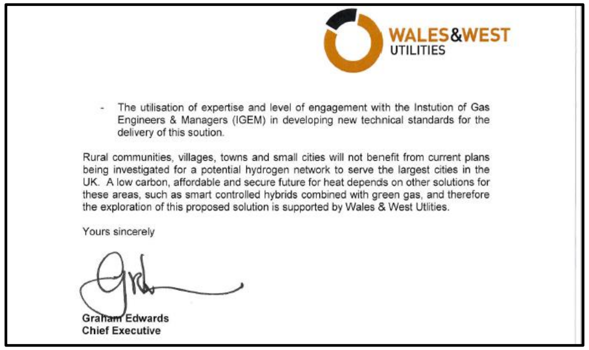

WALES&WEST UTILITIES

- The utilisation of expertise and level of engagement with the Instution of Gas Engineers & Managers (IGEM) in developing new technical standards for the delivery of this soution.

Rural communities, villages, towns and small cities will not benefit from current plans being investigated for a potential hydrogen network to serve the largest cities in the UK. A low carbon, affordable and secure future for heat depends on other solutions for these areas, such as smart controlled hybrids combined with green gas, and therefore the exploration of this proposed solution is supported by Wales & West Utlities.

Yours sincerely

Graham Edwards
Chief Executive

Appendix O: Request for recovery of bid preparation costs

The maximum level of bid preparation costs that we may recover is 5% * £2.156m = £107.8K.

Table O.1 provides a breakdown of our bid preparation costs. We understand that these exceed the maximum level shown above. We therefore request recovery of £107.8K.

Table O.1 – Breakdown of bid preparation costs

Work area	£000's
Project conceptualisation, evaluation and design	9.1
Management of the bid including co-ordination of the parties and submission drafting and editing	21.8
Development of energy demand assumptions and engagement with local stakeholders	9.8
Initial design and costing of daughter station and network	24.2
Financial submission and benefits analysis	33.8
Regulatory and commercial framework analysis	4.0
Legal costs and other expenses	8.8
Total	111.4