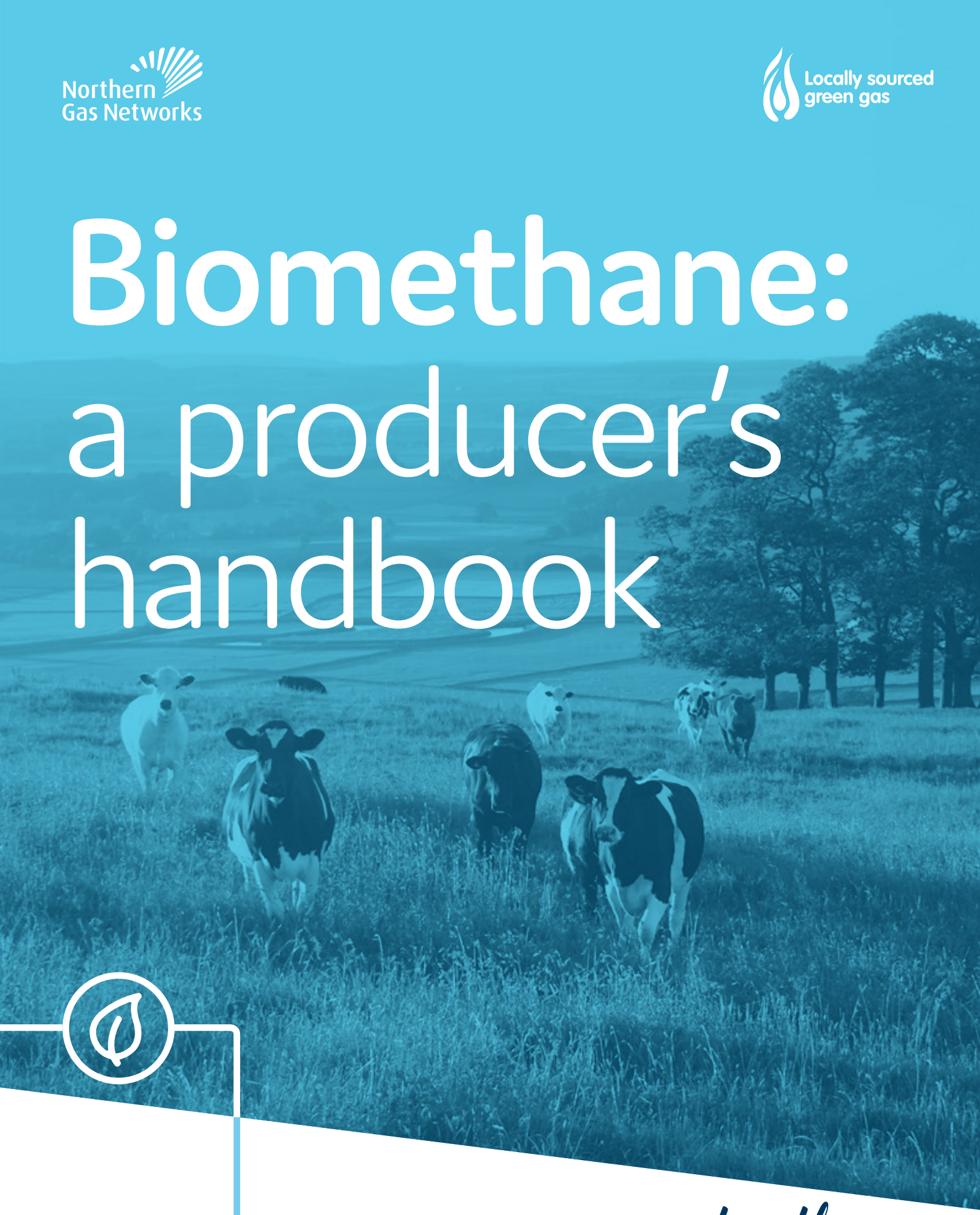
Northern Gas Networks

Locally sourced green gas

Biomethane: a producer's handbook



together we are the network

This handbook provides biomethane producers with a comprehensive guide to every aspect of the process.

Securing the UK's future energy supplies

The UK is committed to bring all greenhouse gas emissions to net zero by 2050.

Biomethane is expected to become an increasingly important element of the nation's future energy strategy, helping to meet environmental targets while reducing reliance on gas imports.

This clean, sustainable fuel can be transported to homes and businesses using the existing gas distribution network, avoiding the costs of widespread infrastructure upgrades.

Retaining gas as part of our energy mix, rather than complete dependence on electricity, will also avoid the need for unsustainable upgrades to electricity distribution networks.

Injecting biomethane into the grid is more energy efficient than using the gas to generate electricity. Around 90% of energy is retained through grid injection, but just 65-70% when combusted to generate electricity.

Exciting opportunities now exist for biomethane producers to make a profit by selling their gas to the grid.

This handbook provides biomethane producers with a comprehensive guide to every aspect of the process – from production to grid injection. It examines the technical aspects of production and connecting to the gas network; the commercial incentives and considerations; and the regulatory requirements.

It is aimed at producers with all levels of experience. We hope it will act as an essential resource to support this burgeoning industry and promote the take up of biomethane technology throughout the UK.

How to use this handbook

This handbook can be used as a reference document, to learn more about specific aspects of the biomethane gas to grid process, or can be read in its entirety, for those seeking a comprehensive picture of the processes, procedures and technical issues involved.

The first half of the document explores the commercial opportunities for biomethane production; provides an overview of the processes and looks at the key pieces of legislation and the stakeholders involved. The second half of the document focuses on the technical aspects of production, such as how to upgrade biogas into biomethane; the key pieces of equipment involved in connecting a biomethane plant to the network and a more detailed examination of the producer's role and responsibilities.

Although some of the content is unavoidably technical, care has been taken to explain concepts, procedures and equipment in accessible language, so that the handbook can be used by those with a non-engineering background.

1

Biomethane
A Unique Opportunity

This section contains:

- **A simple explanation of biomethane and how it is generated**
- **An overview of the market**
- **A summary of the financial opportunities**

As an energy source in the gas industry, biomethane is maturing into a small but integral part of the UK's green energy future. It ticks so many environmental, economic and sustainability boxes that potential producers are discovering an enormous range of advice, expertise and financial incentives to help them unlock a major new income stream.

A steadily increasing number of organisations and businesses, from farmers to local authorities and food manufacturers to water treatment companies are becoming keen to explore the possibilities of turning gas to cash.

1.1 Putting waste to work

Biomethane is a clean, sustainable gas produced from organic material such as green waste; food industry waste; agricultural waste and industrial waste.

In a biological process known as anaerobic digestion, microorganisms break down the material in the absence of oxygen. One of the end products is biogas. Biogas is generally 60% methane and 40% carbon dioxide (with other minor constituents like hydrogen sulphide and oxygen). By 'cleaning' the gas of the impurities, it is possible to end up with 98% pure methane (called biomethane). This product is comparable to natural gas and can be injected into the UK gas network.

Currently, a lot of biogas is used to generate electricity through combined heat and power plants. However, converting biogas into biomethane can be far more lucrative than burning biogas to produce electricity. It is also better for the environment, as much more energy is retained through grid injection, and the escape of harmful methane into the atmosphere (which happens during combustion for electricity generation) is avoided.

1.2 Why the UK needs biomethane

Biomethane has a variety of environmental and socio-economic benefits which help address what the UK government has called a fuel 'trilemma'. The three issues identified are: energy sustainability, energy security and energy cost. These factors are judged to be so crucial to the nation's energy needs that all gas distributors are now measured on how much biomethane is produced and supplied to their network.

1.2.1 Energy sustainability

The production process for biomethane is considered to be a green technology that has a small carbon footprint, as it makes efficient use of existing 'waste' material.

Because of the environmentally friendly production process, the UK government has identified biomethane as an important part of the national energy mix, and has allocated generous tariffs for the supply of this gas into the network. It is anticipated that the adoption of biomethane will help the UK meet its 2020 commitments to supply 15% of energy demand from renewable sources.

1.2.2 Energy security

The use of biomethane in the UK fuel mix provides a level of security as it is produced locally, under controlled conditions. Whilst some renewable energy sources rely on climatic conditions, biomethane production is sourced from a feedstock that will always be plentiful and available. This means that the production gives a high level of assurance. Similarly, the localised production means that there is no risk of international politics or fluctuating financial markets affecting supply.

1.2.3 Energy cost

The utilisation of biomethane gives a level of cost assurance to the UK energy mix. As a source, it is considerably less prone to price spikes.

1.3 Who can benefit?

Farmers, food production companies, breweries and local authorities are just a few of the organisations that stand to benefit from the burgeoning market in biomethane.

By putting their waste to work, businesses and organisations can benefit from an alternative income stream. The benefits are not restricted to individual organisations. There are also opportunities for community-owned biomethane projects.

1.4 The commercial opportunities

Producers can gain an income stream by selling their biomethane to a suitable shipper. The price paid by the shipper, known as the feed-in tariff, will be in line with the gas wholesale prices at the time.

Further financial opportunities are also available through the current Ofgem incentive scheme.

Funded by the UK government and administered by the energy regulator Ofgem, the scheme provides financial incentives for renewable heat producers, including biomethane producers.

For the non-domestic sector, the incentive scheme provides a guaranteed subsidy, payable for 20 years, to eligible producers. The non-domestic Ofgem incentive scheme is open to industry, commercial, public sector and not-for-profit organisations. The subsidy is applied through a rate paid for every cubic metre of biomethane injected into the UK network.

Government support for biomethane projects through the current incentive scheme is designed to promote confidence among producers and stimulate the market in this exciting fuel for the future.

The government sets feed-in tariff rates for biomethane injection and publishes them on the Ofgem website (**www.ofgem.gov.uk**). The tariffs become fixed once a scheme is active, but the tariffs are adjusted annually to reflect the Retail Price Index (RPI).

In order to incentivise the early development of biomethane, the feed-in tariffs are subject to degression– a periodic reduction in financial support provided by the incentive scheme. By applying degression, the government is anticipating that producers will get their projects completed at the earliest opportunity.

The tariffs and associated funds available under the Ofgem incentive scheme are limited and can only be secured when a scheme has been completed, however this may change in the future.

To ensure that an individual scheme receives incentive scheme funding, a projection of the likely funding allocation can be obtained from the Department for Energy Security and Net Zero (DESNZ).

More information can be found at

https://www.gov.uk/government/organisations/department-for-energy-security-and-net-zero

2

Getting Started With A Biomethane Project

This section contains:

- **An overview of the role of the gas distributor in a biomethane project**
- **The crucial role of the Project Manager**
- **Information about start-up costs, and operating costs**
- **Potential sources of funding**

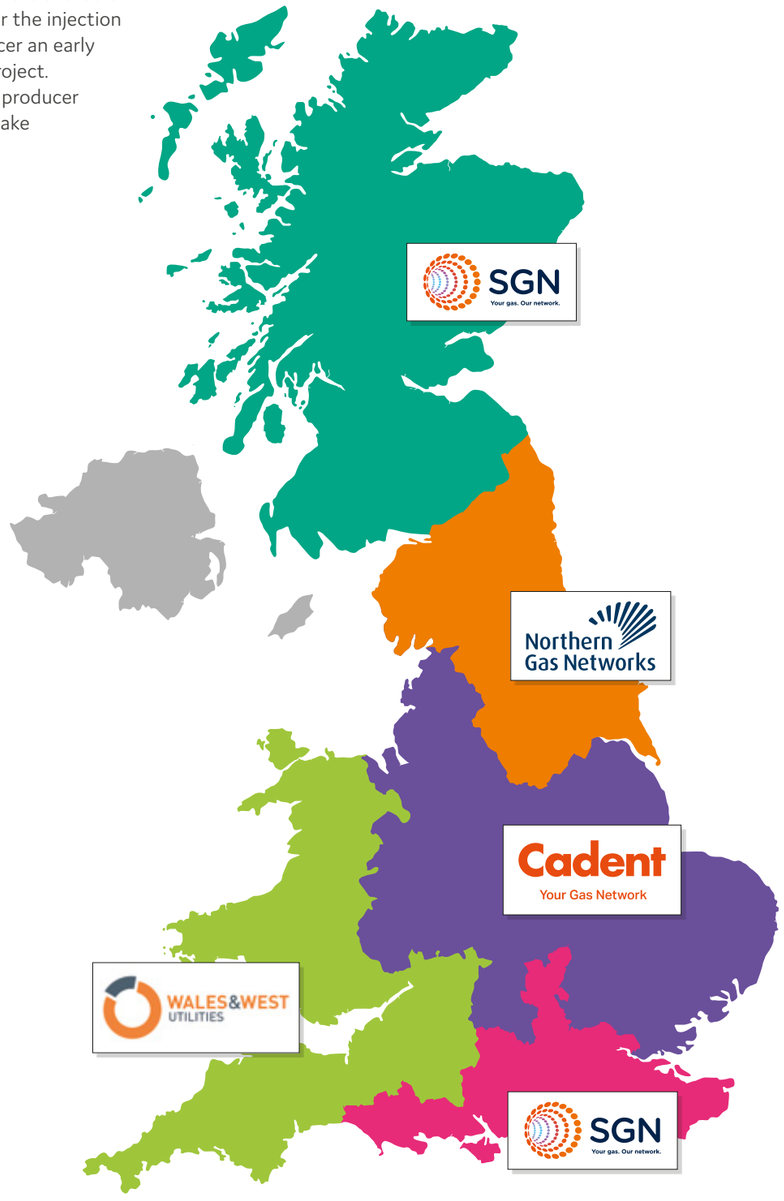
Even though it offers significant financial rewards, the production of biomethane can be a complicated process. As the UK green gas industry matures, the number of specialist practitioners increases. A variety of organisations and consultants now offer advice and expertise on the whys, wherefores, and financial support. A great deal of information can also be found on the internet. However, it should be noted that the quality of this information varies and any potential producer should be wary of putting too much emphasis on information sourced online.

2.1 The role of the gas distributor

The first conversation a potential producer should have is with the distributor who owns and operates the gas network in their region. The distributor will provide information on all the key processes and procedures, and will have specialist employees who can act as a point of contact throughout the lifetime of the project.

The gas distributor will also be able to undertake an initial capacity study to identify if there is available capability within the local network for the injection of biomethane. This will give a producer an early indication of the feasibility of their project. If the initial enquiry is successful, the producer can instruct the distributor to undertake a detailed capacity study.

UK Gas Distribution Map



2.2 Project management

Everyone except the most experienced of producers will need guidance through the process of getting biomethane into the gas network. After initial consultation with the gas distributor the next step should be discussions with a Project Manager.

This is an expert employed by the producer to take their project forward and guide them through the technical and regulatory issues. The producer can utilise the Project Manager as a single point of contact for all queries and, where appropriate, delegate authority for decision making.

The Project Manager will charge a fee for undertaking all the design, liaison and contractual negotiations.

2.3 The feasibility study

Any potential biomethane project needs to begin with a feasibility study – indeed this is essential for attracting funding. This study is usually undertaken by the Project Manager. The feasibility study will contain an overview of the project and organisation; capital investment required; a list of all parties involved with roles and responsibilities and the proposals surrounding the feedstock, maintenance and operation of the site.

The information provided by the gas distributor in the initial enquiry will inform the feasibility of a new project.

There is no such thing as a perfect or a standard scheme. Each project will have its own challenges and individual design requirements. However, an ideal scenario for a producer would be:

- The feedstock supply is reliable, cheap and continuous (not seasonal)
- Land is available
- There is a gas main located nearby
- There is capacity in the gas main for the producer to feed into the main 24 hours a day, 7 days a week
- There is an active market for the by-products of the digestion process (digestates and CO_2)
- The feasibility study should highlight where there may be issues with any of the requirements identified above, and ways that they might be overcome. If a project appears to have insurmountable issues, it may be deemed that the scheme is not financially viable.

2.4 Preparing the business case

Biomethane projects often have considerable start-up costs, so a compelling business case will be required to attract potential investors. This is usually prepared by the Project Manager.

This should focus on the financial projections of the project, including projected incomes and profit, payback periods, and a sensitivity analysis covering issues such as changes to the market or performance of the plant.

An important element of the business case will be assessing the 'critical mass'. This is the amount of feedstock and the associated size of plant required to produce enough biomethane to cover the original cost of the plant and to make a reasonable profit.

There are a variety of ways that producers can improve the balance sheets and lower the critical mass but everyone will have different starting points. Any business involved in a green gas project should strive to maximise existing resources in terms of by-products and assets.

There have been studies done that estimate the minimum level of biomethane production for financial viability is around 150 m3/hr. A producer would need access to 20-25,000 tonnes of feedstock annually.

2.5 Capital expenditure

The potential up-front costs (capital expenditure or 'CapEx') can be significant so producers need to undertake detailed financial analysis of their funding. However, incentives from government via Ofgem's current incentive scheme (see Section 1.4), can make projects commercially viable.

Producers are also advised to investigate the potential grants that are offered by national and local government, as well as charitable organisations. Further details can be found at **www.wrap.org.uk**

Producers have the option to source specialist funding for their projects within the equity markets. Indeed, several active biomethane plants have been funded in this manner.

Potential financiers include:

- The Green Investment Bank
- Equity investors
- Venture capitalists

There are specialist investment forums held every six months by ADBA (Anaerobic Digestion and Bioresources Association) where the private and public sector converge to discuss the latest developments in biomethane financing.

Producers should of course make themselves aware of the conditions that funding organisations impose. For example, it is often the case that the funding party will take a stake in the business. They will also undertake credit checks on individuals within the organisation and will base the lending terms on the outcomes of the credit checks. The lending party will expect repayments to be made regardless of the income being generated by the plant. If the plant does not perform, repayment is still required.

Items that can considerably affect the cost of a scheme include:

- **Using existing land:** readily available, good quality land will save a considerable amount of money. Alternatively, leasing land may help spread costs as opposed to purchasing it. However, this ongoing cost (Operational Cost or OpEx) will need to be calculated.
- **Supply of feedstock:** any ready supply of good quality feedstock will benefit the finances of a project. Conversely, if the supply of feedstock is dependent on other parties, it is important to lower the costs of supply as much as possible. It is preferable to have long-term, binding contracts in place with feedstock providers. This type of agreement (or letters of intent) will help when producers seek funding as the rates paid for feedstocks will influence the business case.
- **Building close to the network:** if the producer is flexible about where the plant will be sited, it is advisable to minimise the distance to the nearest suitable main. If the site of the plant is fixed the distance to the nearest suitable gas main will need to be calculated, as this will affect scheme costs. The location of the UK gas mains are plotted on a Geographic Information System (GIS) so early assessments can be made. Similarly, some gas distributors have highlighted where they know there is demand for gas injection so this may help a producer decide whether to progress their scheme and where to site it.
- It is important to secure a contract for the feed-in of the biomethane. There are a variety of shippers that will look to purchase biomethane from producers but there will be different tariffs and terms on offer. Many of the shippers will be looking for long-term supply agreements, working on periods of 20 years and more. Long-term contracts of this nature are beneficial to producers when they are sourcing funding for their project.

2.6 Operational expenditure

There are ongoing costs that need to be considered and managed by the producer. These are referred to as operational costs or OpEx. Some of these costs will be fixed and some, such as emergency repairs, will be variable.

The following OpEx costs all need to be considered at the planning stage, and carefully managed throughout the lifetime of a project:

- Maintenance costs
- Materials/propane
- Power supply costs
- Salaries
- The cost of emergency repairs
- General running costs

2.7 Understanding the markets and incentives

As in any business, it is critical to ensure that income streams are maximised and all overheads are minimised. The income streams associated with biomethane production include:

2.7.1 Digestates

Digestates are the materials that remain after anaerobic digestion has taken place. It is widely considered that the volume of digestates will be around 85% of the original volume of feedstock. If handled astutely, this material can provide an income stream in its own right.

When the digestate is of the correct quality (physically, chemically and the correct microbial content), it has the necessary characteristics for use as a fertiliser and soil bulker. The digestates from an anaerobic digester are a mixture of fluids (called 'liquor') and fibrous materials. The liquor is generally rich in nitrogen and phosphates, whilst the solid, fibrous material helps to condition and bulk soil with water retentive qualities. This fertiliser can be used privately by the producer to help grow more feedstock, or can be sold in bulk, at a market rate.

If the producer cannot find a market for their digestates, they will need to consider how best to dispose of them. In this scenario, digestates can be handed out free of charge. There are regulatory constrictions on where and how to spread the digestates on soil. Further information on the quality requirements for the use of digestates on soil can be found in BSI PAS 110. This is a British Standard Institution document that has been written to cover the specification requirements for digestates.

Producers may want to investigate the developing technologies that allow good quality digestates to be converted to bio-fuels. This technology is in its infancy but may be investigated by those looking for strong green credentials.

Further information can be found at www.wrap.org.uk

2.7.2 CO_2

Biogas, the raw form of biomethane, consists of 60% methane and 40% carbon dioxide (CO_2). Carbon dioxide does not have any calorific energy and is superfluous to biomethane production but it does have a market rate. It is separated from the methane during the cleaning process. It can be bottled and sold to

commercial greenhouses, who will use it to increase crop yields. CO_2 can also be useful as a ballast gas to manage the biomethane within GSMR limits.

2.7.3 Feedstock

Astute producers may be able to source feedstock suppliers who will pay to have their feedstock taken away, as it can work out cheaper than disposing in landfill. This process of buying and selling feedstock is referred to as 'gate fees'. Gate fees can be up to 60% lower than landfill tax.

2.7.4 Combined Heat and Power plants

If there is a period where biomethane cannot be injected into the grid, due to capacity constraints or gas quality issues, there are options for producers to sell their biogas for use in Combined Heat and Power plants, which generate electricity. This market is not as lucrative as the biomethane market but it can offer an alternative outlet.

2.7.5 The Ofgem Incentive Scheme

The incentive scheme is run by Ofgem on behalf of the Department for Energy Security and Net Zero (DESNZ).The scheme is designed to give long-term financial assurance to non-domestic renewable heat generators and biomethane producers.

For more information on the current incentive scheme, please see Section 1.4

2.8 Understanding contractual arrangements

From the outset, the contractual set-up of the producer's own organisation will need to be considered. Will it be an individual funding the scheme? Is it a collection of organisations that are in a joint venture or is it a group of colleagues who are contractually bound by an agreement?

Producers will be required to sign a number of contracts with external organisations at various stages of the project, such as:

- Contract with feedstock suppliers
- Contract with a gas shipper
- Contract with a project manager
- Contract with designers
- Contract with Engineering Procurement & Construction Contractor (EPCC)
- Contract with land owners
- Contract with Delivery Facility Operator covering operations and maintenance
- A secured tariff under the current incentive scheme This will secure a tariff for the next 15 years

2.8.1 Contracts with shippers

In addition to the incentive, producers will be paid a tariff by the shipper. The feed-in tariff will depend on the contractual arrangements with the shipper. The price paid by the shipper will be in line with the gas wholesale price at the time of payment. A number of gas purchasers are looking to purchase green gas for use in low carbon, localised district heating schemes. The system notionally allows for the green gas to be injected into a discrete part of the grid for use by consumers who want to enhance their green credentials.

3

Working With Stakeholders

This section contains:

- **A summary of the key stakeholders involved in a typical biomethane project**

A wide range of third party organisations have a role in any biomethane project.

3.1 Shippers

A producer will need to have a commercial agreement with a gas shipper. Commercial gas shippers are often household names. They buy gas on wholesale markets and sell it to suppliers. Gas shippers pay the gas distributors to transport their gas to the end users.

The agreement between the producer and shipper can be negotiated but shippers are generally looking for long-term agreements. There may be maximum and minimum supply volume limits within the agreement.

3.2 Gas Distribution Networks (GDNs)

There are four main gas distributors in the UK: Northern Gas Networks, Cadent, Wales and West Utilities and SGN. Each owns and operates the gas distribution network in their area, carrying out planned maintenance, improvement work, and emergency repairs.

All gas distributors have been challenged by Ofgem to reduce the carbon footprint of the UK's total gas consumption by increasing the volume of 'green gas' entering the network. In response, distributors are actively supporting biomethane projects, by working closely with producers to get their gas to the grid.

Biomethane producers should approach their regional gas distributor very early in the process, as they are a crucial partner.

A producer will need to have a Network Entry Agreement (NEA) with the distributor to be able to supply gas into the grid. This is a signed agreement between the producer and the distributor and covers key issues such as the quality of the gas, measuring the volume of gas injected and ongoing quality monitoring.

For more information about the Network Entry Agreement, see Section 8.2.

3.3 Delivery Facility Operator (DFO)

A DFO is employed by the producer to operate and maintain the production facility in line with the Network Entry Agreement. In most cases the DFO is the producer, but in some instances the producer may decide to employ a third-party organisation which specialises in this field.

3.4 Utility Infrastructure Provider (UIP)

This is a pre-accredited contractor that has been deemed fit and proper to work on the UK gas network. The producer is free to select any UIP that they choose to deliver the project, as long as they are accredited.

3.5 Ofgem

The Office of Gas and Electricity Markets. This is a non-ministerial office that regulates the UK's gas and electricity networks. Ofgem has been appointed to administrate the current incentive budget set by DESNZ.

Ofgem may not have direct involvement with a biomethane plant's construction but do require prescribed pieces of information. Predominantly, they will require the manufacturer details for the Calorific Value analyser, a critical piece of equipment that measures the energy content of the gas being produced. Ofgem requires assurance of the quality and accreditation of this equipment. They may also request to see where the sampling point is located so that there is assurance about the Calorific Value measurements.

3.6 Xoserve

A third-party company that provides centralised information and data services for gas transporters and shippers.

3.7 Department for Energy Security and Net Zero (DESNZ)

A ministerial department responsible for ensuring that the country has secure energy supplies that are reliable, affordable and clean.

3.8 Council planning department

Any scheme that requires a considerable level of industrial plant will need to obtain the relevant planning permission from the local council. A producer will need to approach their local planning department at an early stage.

3.9 Health and Safety Executive (HSE)

The Health and Safety Executive oversees the safety regulations governing construction and civil engineering schemes.

It should be noted that all High Pressure (HP) main connections require up to 12 months notification to the HSE.

3.10 Environment Agency (EA)

The Environment Agency has regulatory controls around the use of digestates as a fertiliser (see Section 2.7.1 for more information about digestates). Further information can also be found at **www.environmentagency.co.uk.**

3.11 Speciality plant suppliers

Some of the plant and equipment required to produce biomethane has been around for many years, whilst other parts are very new technology. To ensure that a producer gets the best advice, they should seek guidance from an experienced Project Manager.

As the biomethane industry continues to grow, there are an increasing number of suppliers who specialise in the production of biomethane generating equipment. Suppliers will often provide a 'turn-key' solution.

This means they will act as project managers, designers, and will also build the plant.

Producers should ensure that their consultants and suppliers are experienced in all the legislative and the regulatory requirements.

4

Production Process: Feedstock to Gas Clean-Up

This section contains a summary of the biomethane production process including:

- **Enhancing the feedstock**
- **Anaerobic digestion**
- **Removing moisture from biogas**
- **Upgrading biogas into biomethane**

There are several key stages in the production of biomethane. This section summarises the key steps.

4.1 Step 1: Pre-digestion enhancement

There are a variety of processes or enhancements that can be applied to feedstock prior to anaerobic digestion in order to improve the gas production and improve the quality and value of the digestates which are left behind.

These processes are as follows:

Enzymic Liquefaction

Enzymic Liquefaction uses a two-stage process to breakdown the feedstock. Firstly, the feedstock is treated with steam to help reduce and 'open' the feedstock. Secondly, the process introduces enzymes, to help liquefy the feedstock. This feedstock is then sent to the digester.

Autoclave Systems

An autoclave is a pressurised heating chamber which heats, treats and breaks down the feedstock prior to digestion. This helps to remove moisture (therefore reducing mass) and helps start the digestion process.

Thermal Hydrolysis

This process uses a steam and pressure treatment on the feedstock prior to digestion. This treatment helps break down cell structure in the feedstock, enabling microbial digestion at a more productive rate. It also removes initial moisture from the feedstock, allowing higher feedstock loading within the digester. This results in quicker, more bountiful biogas production.

4.2 Step 2: Anaerobic digestion

In an anaerobic digester, feedstock is mixed with digesting material in a sealed tank at an elevated temperature with no oxygen present. The digesting material contains naturally occurring bacteria that breakdown the feedstock to produce biogas and stabilised digestate. The biogas is transported away for further use and with each feed cycle, digestate is displaced. The nutrient rich digestate can be used as a fertiliser.

4.3. Step 3: Treatment

After anaerobic digestion, the next stage in the process is to remove the moisture out of the biogas. There is inherent moisture content within biogas and the easiest way to remove it is by cooling the gas so that it condensates.

4.4 Step 4: Upgrading

Once treated, the biogas moves into the Biogas Upgrading Plant (BUP).

The main function of the BUP is to change biogas into biomethane. There are currently four fundamental technologies that can be used to convert biogas to biomethane:

Water Scrubbing: where the biogas is forced against a counter flowing column of water

Amine Scrubbing: where the biogas is exposed to an amine gas that will absorb various contaminants

Pressure Swing Absorption: where the biogas is exposed to different elements so that the associated chemical reactions result in the removal of contaminants

Membrane Separation: where a membrane is used to filter contaminants

Each technology has its strengths and weaknesses, but the most commonly used in the UK is Water Scrubbing. The technology used can be affected by the feedstock, the production rates, costs and plant space. Specialist consultants are able to advise which technology is most appropriate for any given situation.

The output from the BUP is biomethane. However, before it can be injected into the grid, there needs to be further analysis and treatment to the gas. The analysis and treatment is undertaken in the Biomethane Network Entry Facility (BNEF), which is described in more detail in the next section.

4.5 Assessing the biomethane facility

As part of the gas to grid process, the local gas distributor or its framework designers will need to carry out a risk assessment of the producer's biomethane facility in order to access the required measurement provisions for gas quality, calorific value and flow measurement.

This process, known as a GQ/8 workshop, will be attended by the distributor, the producer and the producer's designers.

This workshop is critical and must be carried out early in the design process so that there is clear understanding of the quality of the gas.

5

Gas Injection: An Overview

This section contains:

- **An explanation of the key pieces of equipment needed to connect a biomethane plant to the gas distribution network, including an introduction to the Biomethane Network Entry Facility (BNEF)**
- **An overview of the responsibilities of the producer and the gas distributor**
- **A summary of network grid pressures**

There are a number of technical processes that the biomethane needs to go through, before it can be injected into the gas network, so that it matches the quality of the natural gas already in the grid.

This section summarises these processes. Further detail is available in the Technical Section later in the handbook (Section 7).

5.1 Biomethane Network Entry Facility

The Biomethane Network Entry Facility (BNEF) comprises several crucial pieces of equipment which ensure that the biomethane is compliant with all necessary standards and regulations, before it enters the gas network.

Producers must deliver biomethane which is compliant within the requirements of:

- The Gas Safety (Management) Regulations (GS(M)R)
- The Gas Calculation of Thermal Energy Regulations (GCOTER)
- The Uniform Network Code (UNC) and the Network Entry Agreement (NEA)

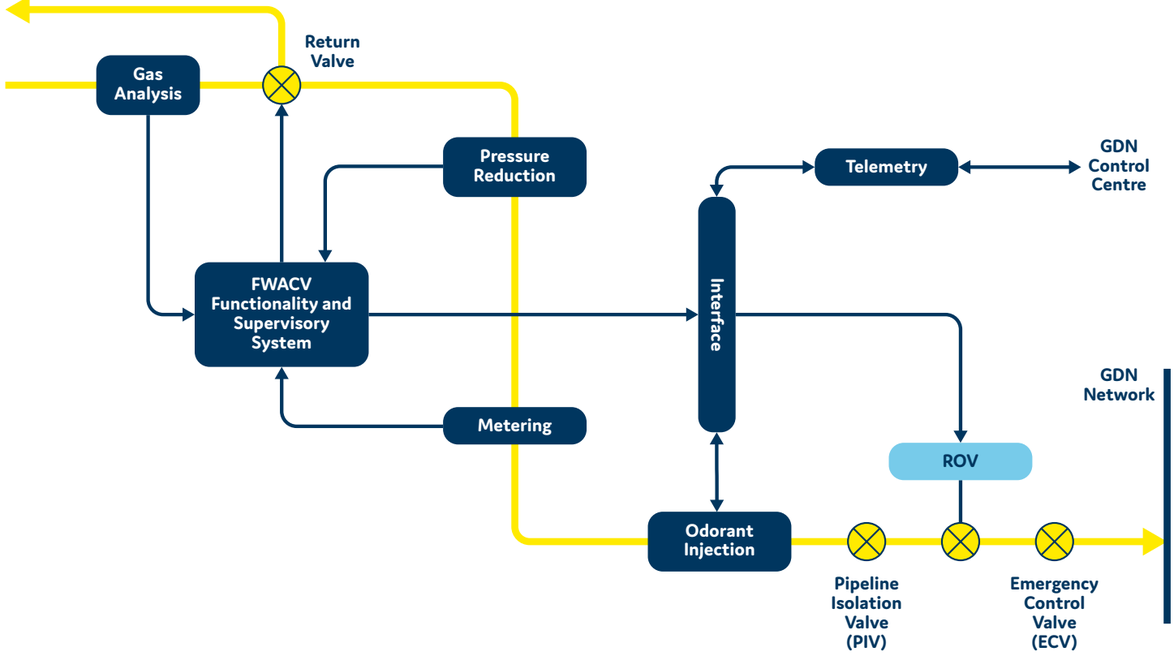
More details on these can be found in Section 10.

5.2 How the BNEF works

The BNEF performs the following key tasks:

- **Gas pressure reduction and control:** so that the gas pressure is always correct to satisfy the gas network
- **Gas analysis for compliance monitoring:** the gas is tested for contaminants
- **Metering:** the volume of gas needs to be measured and recorded
- **Odorant injection:** the gas needs to be given the distinctive 'gas' smell. The producer may need to operate the odourising equipment but this requirement can change between different gas distributors
- **Flow Weighted Average Calorific Value functionality:** the energy content of the gas being injected into the grid needs to be measured and recorded. The calorific value must match the value stipulated by the local gas distributor
- **Propanation:** Where there are any short-falls in the calorific value of biomethane, propane can be added. It is preferable for this process to take place within the BNEF, but it is also feasible for this to be delivered in the Biomethane Upgrading Plant

The anatomy of a Biomethane Network Entry Facility



Ultimately, if there are any quality issues once the gas leaves the BNEF, the gas is rejected and will not enter the grid. The rejected gas will either go to 'flare' (burnt off) or it is recycled and reprocessed back through the BNEF.

5.3 Who owns what?

There are a range of options regarding the ownership of the BNEF. These often depend on the stance of the local gas distributor.

The general assumption is that the producer will own and operate the BNEF except for the Remote Operating Valve (ROV) – the final valve before gas enters the gas network, the Remote Telemetry Unit (RTU) and Odorisation Unit. The RTU is the communication device between the BNEF and the Gas Distributors Control Room. The odorisation unit introduces the recognised or standard 'gas smell' into the biomethane.

These three pieces of equipment are vital to gas security and the distributor will want to ensure that they have the necessary control to stop gas entry when necessary.

5.4 The HAZOP study

All distributors have strict rules about the adoption of equipment. To make the process easier, there will need to be a HAZOP (Hazardous and Operability) study undertaken to support the design of the BNEF. This is a requirement before the design has been finalised. A study is undertaken on the design and infrastructure to ensure that all risks are minimised. It may be undertaken by an independent third party and should be completed as early as possible.

The findings and recommendations of the HAZOP will need to be reviewed and accepted by the distributor.

5.5 Export Connection Pipe

The Export Connection Pipe is the main that takes the biomethane from the BNEF through to the gas network.

The size of this pipe will depend on the volume and pressure of the receiving network main and the distance between biomethane production facility and the receiving network. The aim would be to minimise the pressure loss between the BNEF and the point of connection to the gas network.

Producers will be made aware of the necessary length and size of the export pipe within the detailed capacity report provided by the gas distributor during the planning stages (see Section 8.1 for more details about capacity studies). They may also be advised of estimated costs to build and connect the mains in the detailed capacity study.

5.6 Connection to grid

The UK gas network runs a pressurised system that holds gas within pipes. There are 4 designations of pipe pressure:

- High Pressure: >7 bar
- Intermediate Pressure: >2 – up to 7 bar
- Medium Pressure: >75 mbar – up to 2 bar
- Low Pressure: Up to 75 mbar

With all things being equal, the higher the pressure in the pipes, the more gas accommodated in the system. As such, it is often preferable for a producer to connect into a high pressure main as there is a greater chance that there will be capacity available. However, the cost of connecting into a high pressure main is considerably more.

All connections below 7 bar can be done through a Utilities Infrastructure Provider (UIP), the certified contractor that can lay gas mains and connect to the network.

6

Gas to Grid: A Five Stage Process

This section contains:

- **A description of the key stages involved in connecting a biomethane plant to the grid**
- **An overview of how a connection is designed, and the personnel involved**
- **An explanation of how to reserve a connection point on the network**
- **An overview of the construction process**
- **Details of the inspection process for a completed project**

There are usually five key stages in a biomethane project, from initial contact with the local gas distributor to construction and connection.

6.1 Stage 1: Identifying capacity

The first crucial step is for the producer to find out if the local gas network has adequate capacity to accept their biomethane. A network capacity enquiry can be submitted to the distributor who will respond within 15 working days.

The distributor will also provide feedback on the location, pressure and diameter of the nearest mains. A map of the area will be provided, showing the location of the nearest potential entry point. The report will indicate whether the nearest main is suitable for biomethane injection. It should be noted that this information is only a guide, not a final decision.

6.1.1 Commission a capacity study report

Once the producer has received the initial capacity assessment from their distributor, and feels confident about the viability of the project, they can then proceed to a more detailed capacity study.

There is a fee associated with this report. The report should provide far more detail than the initial capacity study and is likely to cover:

- Potential entry points for the export pipe (the pipe connecting the biomethane facility to the grid)
- Daily gas demand profiles for the local network
- Sensitivity analysis on the system to identify the plus and minus tolerance within the system and how that will impact the projects viability
- Indicative costs for the connection pipe and the Biomethane Network Entry Facility – essential equipment which ensures the biomethane is of the required quality standards for grid injection

The capacity study will be produced within 30 working days of payment.

6.2 Stage 2: Securing the connection point

A gas distributor will allow the producer to reserve their chosen connection point on the network whilst their project is progressing. That way, they can be assured that the connection point is waiting for them once the project is ready. The distributor will formally notify the producer that they can apply to reserve a connection point and an application form will need to be submitted.

Generally, the producer can start the process of securing a connection point as soon as they received a capacity study or have committed to detailed design services. This will be very early on in the process. The chosen connection point is usually the receiving main nearest to the producer's biomethane plant.

As the name suggests, a connection reservation is only a reservation. However, it is a big commitment from the gas distributor, as it requires them to acknowledge the scheme from that point on in their future calculations and plans.

After the reservation has been made the producer has nine months to complete their project so that it is ready to connect. During this nine month period, the producer will need to keep the distributor fully updated, via monthly progress reports. The reports will need to satisfy the distributor that good progress is being made and that the producer still has full commitment to the scheme.

If, during the nine months, there is concern that the scheme has not satisfactorily progressed, the producer will have the right to withdraw the connection reservation. However, if the scheme is judged to be making adequate progress, but needs additional time to complete, the producer can complete an extension request form to gain an additional six months.

6.3 Stage 3: Detailed design

Once a producer is confident that there is suitable capacity within the local gas network, the whole of the scheme can then be designed.

All designs must be assessed and validated by the gas distributor to ensure they comply with industry standards. A fee will be charged for these services. The producer has responsibility to design the following:

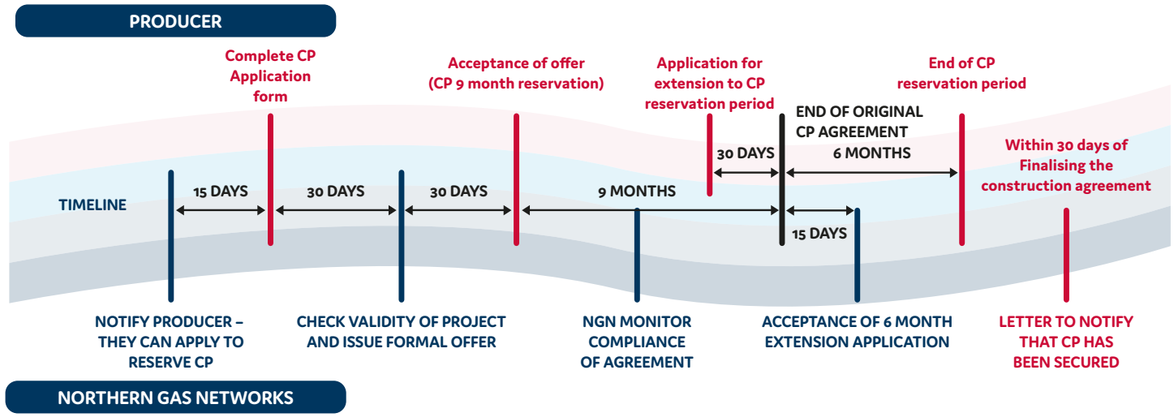
BNEF: the whole of the BNEF will need to be designed by the producer's team. The design will need to comply with G/17 and GL/5 standards.

The producer will also need to employ technical representatives, to ensure that the design meets the below standards:

- **IGE/GL/5 Edition 2:** the IGEM recommended advice on the procedures for the management and control of new works, modifications and repairs to all plant or systems associated with the supply of natural gas.
- **NGN/PM/G/17:** the Gas Distributor's Management Procedure which applies to the management of new works, modifications and repairs incorporating commissioning, operational and asset acceptance.

The roles and responsibilities that need to be filled are captured below. Some of the roles will be covered by one consultant:

Competent Design Authority	The Competent Design Authority (CDA) is a body appointed by the gas industry having responsibilities for the project design. They hold a register of design approvers and appraisers to be employed in the design acceptance process.
Commissioning Engineer	The Commissioning Engineer is an engineer within the company or within an external organisation with the relevant competencies and authority to commission and put systems into use.
Design Appraiser	The Design Appraiser is an engineer with the relevant competencies to appraise design work in a specified discipline(s). The Appraiser must be demonstrably independent of the work to be appraised. Appraisers must be nominated through the project plan or in writing to the Project Manager. Appraisers should be on a CDA Register.
Design Approver	The Design Approver is an engineer with the relevant competencies to approve a design that meets the requirements of the contract or design brief, legislation, standards and is safe. Design Approvers must be nominated through the project plan or in writing to the Project Manager. Design Approvers should be on a CDA Register.
Design Organisation	The organisation which undertakes the design stage of a project.
Installer	The person or organisation who undertakes installation, inspection, testing and commissioning activities. The Design Organisation and the Installer may be part of the same company.
Project Manager	The manager or engineer with responsibility for the management of the project. The Project Manager ensures that the project progresses through all of its stages from the initiation stage to the final commissioning stage, and that all of the relevant drawings, test results and paperwork are completed. The Project Manager or technically competent person must verify on site that the works have been carried out and are fully completed as per the approved design and compliant with all relevant Transporter Technical Documents and Specifications.
User	The User is a person representing the GDN who has responsibility for the work being constructed, modified or repaired and who grants approval for work to be undertaken.



6.4 Stage 4: Documentation

The next stage for the scheme will be the completion of documentation.

The producer and transporter will need to sign the following agreements throughout the life cycle of the project.

- **Network Entry Agreement:** this is a comprehensive document detailing how both the DNO and DFO will operate such that the gas entry is managed in accordance with regulations. It is a prerequisite in order to gain Ofgem incentive payments
- **Construction Agreement:** this is to procure the works the distributor will be responsible to deliver
- **Adoption Agreement:** this agreement transfers the ownership of certain elements of the BNEF to the gas distributor

Please see Section 8 for a more detailed explanation of each of these agreements.

In addition to these three key agreements, a design services agreement will also be required if the distributor is instructed to undertake design of the Remote Operable Valve, export pipe and the physical connection to the mains on behalf of the producer. This is optional for all schemes.

The design agreement will detail:

- The value of the works
- The design scope
- Delivery dates
- Obligations for each party
- Dispute resolution procedure

6.5 Stage 5: Construction and commissioning

The physical construction can get underway once a Construction Agreement has been signed (see Stage 4 above). Some of the works may need to be carried out by a contractor appointed by the distributor. Where this is not necessary, the producer can appoint an approved contractor of their own choosing.

As the construction phase progresses, a monthly progress report will need to be issued to the gas distributor.

When the site is ready, the distributor will need to inspect, test and commission all the necessary elements and ensure everything has been completed in accordance with the gas distributor's minimum functional specification, the detailed design requirements and the GL5 and G17 processes for the BNEF.

Key elements of the inspection/commissioning process include:

G17/GL5 approvers and/or appraisals: the producer must arrange for the G17/GL5 approvals and/or appraisals to be undertaken on all relevant plant (note that G17 is required for plant adopted by the distributor and GL5 is required on all other plant). This activity can take up to 6 weeks and time should be allowed in the programme.

Establishing the odorant rhinology test point: prior to construction, the producer needs to get confirmation from the gas distributor on the odorant – rhinology test point. This is the location within the export pipe where the necessary parties can manually check that the gas being exported for injection into the network has been dosed with the correct levels of odorant.

A standard reference gas test: the producer must arrange for a standard reference test on the gas being produced by the plant. This will be carried out by an independent expert accredited by Ofgem. This should be arranged immediately after the BNEF has been installed and the gas analyser (the component that measures gas quality) is powered up and stabilised. The test can be carried out before the plant is gassed or connected as the test is carried out on a reference/calibration gas.

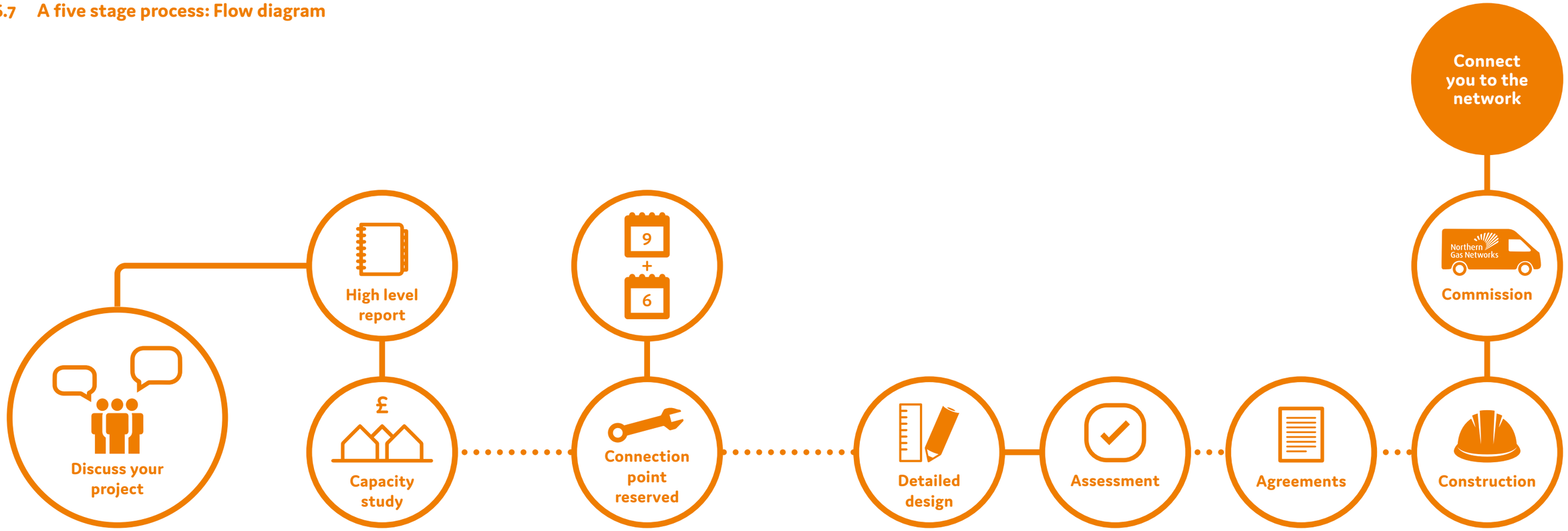
The independent examiner will receive and review the standard reference gas test report and associated test results and, assuming everything is in order, will issue a Letter of Direction granting the final authority required to inject gas. Without this letter, injection is not permitted. The letter will detail an agreed date from which gas will be allowed to be injected, although the actual date that gas injection starts may be after this date.

6.6 The '12 week rule'

If the producer has a pre-determined date for gas injection to commence, it is recommended that they notify the gas test company 12 weeks prior to the gas-on date. The 12 weeks will consist of:

- Six weeks' notice for the standard reference gas testing company to attend site. This will ensure that they have personnel available.
- A further three weeks following the inspection for the standard reference gas test report to be produced (sent to the gas distributor in the first instance). Note within this report is the telemetry data. The control centre require a minimum of eight weeks' notice of this final telemetry Input/Output Schedule so all systems from DNO through to National Grid and Xoserve can be developed, tested ready for the gas on day.
- One week for the examiner's visit (this can actually be any time after the sample point has been installed in the BNEF).
- One week for the Letter of Direction to be applied for.

6.7 A five stage process: Flow diagram



We will work with you every step of the way to get your biomethane facility connected to our network, so you can start turning your gas into cash.

Stage 1: Network capacity

We'll meet to discuss your project, its scope and objectives. Armed with this knowledge, we'll produce a free, high level report for you, identifying available network capacity and the feasibility of your project.

If the initial assessment is encouraging, we'll move on to a more detailed 'capacity study'. This sets out your connection options; the available capacity of the local network under different conditions (e.g. cold days and warm days); proposed pipeline route; plant and equipment and indicative costs for the project.

Stage 2: Reserving your connection

Once your capacity study has been completed, you will be able to reserve your connection point on our network.

Your connection point will be reserved for 9 months, with the option to extend the reservation for a further 6 months if you end up needing more time to commit to a construction agreement.

Stage 3: Designing your connection

Our engineers will work up a detailed design for the connection or you may wish to commission your own design, which we would then validate.

Stage 4: Paperwork

There are several crucial agreements that need to be signed before the project can progress to injecting gas into the gas distribution network.

These include the Network Entry Agreement, the Adoption Agreement and the Construction Agreement. The Network Entry Agreement can be downloaded from our biomethane website – **biomethane.northerngasnetworks.co.uk**

Stage 5: Construction and completion

It's time to make your plans a reality. Depending on the agreed design solution, the construction work may need to be carried out by an NGN appointed contractor (e.g. if you are connecting to a high pressure main) or an approved provider of your choosing.

Once you are ready to connect, we will carry out a site examination, to ensure everything has been completed according to our network adoption criteria.

If your project meets all the requirements, we'll get you connected so that your biomethane, and revenue, can start flowing!

7

Technical Section

This section contains technical detail on:

- **Biomethane Network Entry Facility (BNEF), including:**
  - **Pressure regulation and control**
  - **Gas analysis**
  - **Metering**
  - **Calorific value measurement**
  - **Housing**
- **Biogas Upgrading Plant (BUP)**

This section provides more detail about the key processes and equipment introduced earlier in the handbook.

It will help producers and their consultants to explore the technical aspects in more detail.

Even here, it is impractical to cover every single aspect, so producers are advised to speak to or with their gas distributor where further information is required.

7.1 Gas production to grid entry

A typical biogas to grid installation comprises:

- Anaerobic digestion plant, including a source of heat input to the biological process
- Biogas system comprising a gas holder, drier and boosting equipment
- Biogas upgrade system to remove other gases and concentrate the methane
- Propanation to increase the biomethane to the correct calorific value
- Biomethane Network Entry Facility (BNEF) to monitor quality and quantity of the biomethane prior to entry to the grid – includes the odorisation plant
- Reject gas facility to return biomethane that is not compliant to the gas production facility for further improvement or flaring
- Remote Operated Valve (ROV) owned and under the control of the gas distributor. The ROV will close if the gas produced from the facility is not compliant with regulations. Non-compliant gas is almost always detected (and then rejected) by the BNEF, but the ROV acts as a final emergency barrier, if required.

More about the biogas upgrading plant

The biogas upgrading plant (BUP) takes in biogas that will generally be comprised of 60% methane with the bulk of the remaining gas being carbon dioxide (CO_2). Whilst the BUP is not part of the BNEF it is essential to the production of compliant biomethane that can be injected into the grid.

The source of feedstock into the anaerobic digester will determine the constituents of the biogas produced. The BUP should be designed to achieve compliant biomethane across the range of gases that could be produced from any variation in feedstock.

The core functions of the BUP are as follows:

Gas cleaning

In order to achieve the necessary calorific value (CV) and quality for injection, the majority of the non-methane gases must be removed from the biogas. Once cleaned the biogas is known as biomethane.

Pressure regulation

Depending on the type of biogas facility installed and the pressure of the gas grid, the biomethane will require pressure regulation – either boosting or reduction. This will be controlled by compressors.

Gas enrichment

Biomethane is enriched with Liquefied Petroleum Gas (LPG), the usual material used is commercial propane. This stage is generally referred to as 'propanation'. Biomethane is generally required to be enriched to ensure that the gas meets the required CV as determined by the Flow Weighted Average Calorific Value (the amount of energy required in the gas which can differ according to the requirements of different gas distributors). Note there can be issues with Wobbe, ICF or SI caused by heavy use of propane when pure methane is generated.

The addition of liquid propane will cool the gas after addition and gas pre-heating is normally required as part of the propanation plant. The final temperature of the biomethane is required to be within the limits set out in the Network Entry Agreement. The propane must not mask or effect the odorant being injected downstream.

More about the Biomethane Network Entry Facility (BNEF)

The BNEF ensures the biomethane is compliant with the requirements of the gas distributor set out in the Network Entry Agreement (NEA). To achieve this, a BNEF performs the following functions:

Gas analysis: measuring the constituent parts and the calorific value (CV) of the gas

Flow metering: measuring the quantity of biomethane that is injected for billing purposes

Pressure control: to prevent over pressurised biomethane entering the grid

Temperature measurement: to ensure that the temperature of the gas is kept within specified limits

Odorant injection: to give the biomethane the characteristic gas smell

Communication (telemetry): equipment to send all necessary data to the gas distributor to demonstrate compliance with gas quality standards and regulations

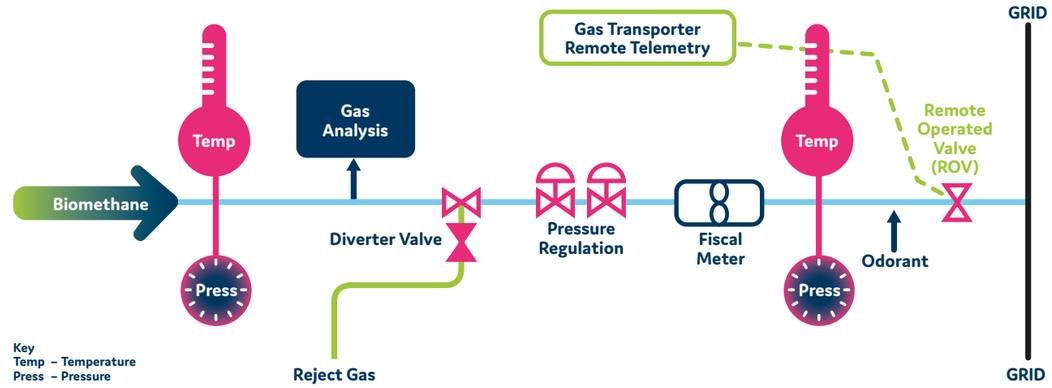
Each gas distributor will have a reference document titled Minimal Functional Specification for the BNEF. This document will detail the requirements for a safe, efficient and fit for purpose BNEF installation. A biomethane producer should ensure that they consult this document from the outset of the project.

BNEF housing

The BNEF will be contained within a BNEF housing which usually consists of a robust, weather resistant building material. The housing will need to provide a secure cover for the following key pieces of equipment:

- Pressure reduction and control
- Gas analysis for compliance monitoring
- Metering
- Odorant injection
- FWACV functionality
- Supervisory system

BNEF – Block Schematic Diagram



The specification and requirements for the housing performance will be contained within the gas distributors Minimum Functional Specification Requirements.

Depending on the gas distributor's requirements, the elements listed may be supplied, owned, controlled and maintained by the producer (known as the 'Minimum Connection Model') or supplied, owned, controlled and maintained by the gas distributor (known as the 'Maximum Connection Model').

The ROV, the final section of the BNEF, is always the property of and controlled by the distributor.

In addition to the equipment listed in this section the BNEF, and pipeline prior to it, requires a Diverter Valve to return non-compliant gas to the anaerobic digestion production facility and/or to flare.

7.1.1 Pressure regulation and control

The delivery of biomethane has to be at a sufficient pressure to meet requirements without exceeding the Maximum Operating Pressure of the downstream pipeline. If necessary, the pressure of the biomethane can be raised prior to the BNEF. Pressure regulation and control needs to meet the recommendations set by the Institution of Gas Engineers and Managers (IGEM/TD/13). See Section 12 for more details of these standards.

7.1.2 Gas analysis for compliance monitoring

The BNEF has to be capable of supplying all of the necessary information and data to assure the distributor and producer that the gas being injected into the grid is compliant.

The BNEF has to measure or calculate the following determinants on Ofgem approved analysers:

- O_2
- CO_2
- CH_4
- N_2
- H_2S
- CV
- Wobbe Index
- Density
- Compression Factor
- Sooting Index
- Incomplete Combustion Factor
- Water Dew Point

In addition to the analytical instrumentation the following data is required as a minimum:

- Gas Flow
- Inlet Pressure
- Outlet Pressure
- Inlet Temperature
- Outlet Temperature
- Odorant Flow Switch
- Odorant system alarms/monitoring
- Position of diverter valve

7.1.3 Metering

Metering systems need to be designed in accordance with standards set by the Institution of Gas Engineers and Managers. See Section 10 for more details.

The producer should be aware that the metering is required to be calibrated on Natural Gas at a UKAS accredited (or equivalent) test centre.

7.1.4 Flow Weighted Average Calorific Value (FWACV) functionality

The gas sold to customers is priced on the FWACV. Consequently, distributors must keep a detailed account of the average calorific value of the gas being injected.

The calorific value of the biomethane must be measured and recorded by instrumentation that has been accredited by Ofgem. This accreditation will be confirmed in the Letter of Direction. The wider plant installation must also be designed by the producer's team to deliver all FWACV requirements set out in the regulations and the Letter of Direction.

Data management for FWACV and import to the UK-wide billing system is computed by National Grid Transmission and afterwards managed by Xoserve on behalf of all shippers, gas distributors and consumers. Xoserve require:

- Receipt of data (in specified electronic file format) at end of gas day (data is total energy flowing into the grid and average CV of such energy)
- Communication of data files using ISDN link
- Calculation of FWACV is to be performed by an approved methodology and approved software
- Producers should consult their Letter of Direction and the Gas (Calculation of Thermal Energy) Regulations

7.1.5 Odorant injection

Typically, odorant injection systems are installed on systems substantially larger than those to be found on a gas to grid biomethane project. However, the system needs to be designed in accordance with the principles of any typical odorant facility, and must comply with the IGEM/SR/16 standard (see Section 10 for more details about this standard).

The instantaneous flow rate from the flow meter is used by the odorant system to control the correct odorant rate.

The rhinology test point location is to be agreed with the distributor. This is a point within the export pipe (after the ROV) where monthly, manual gas testing can be undertaken by the transporters.

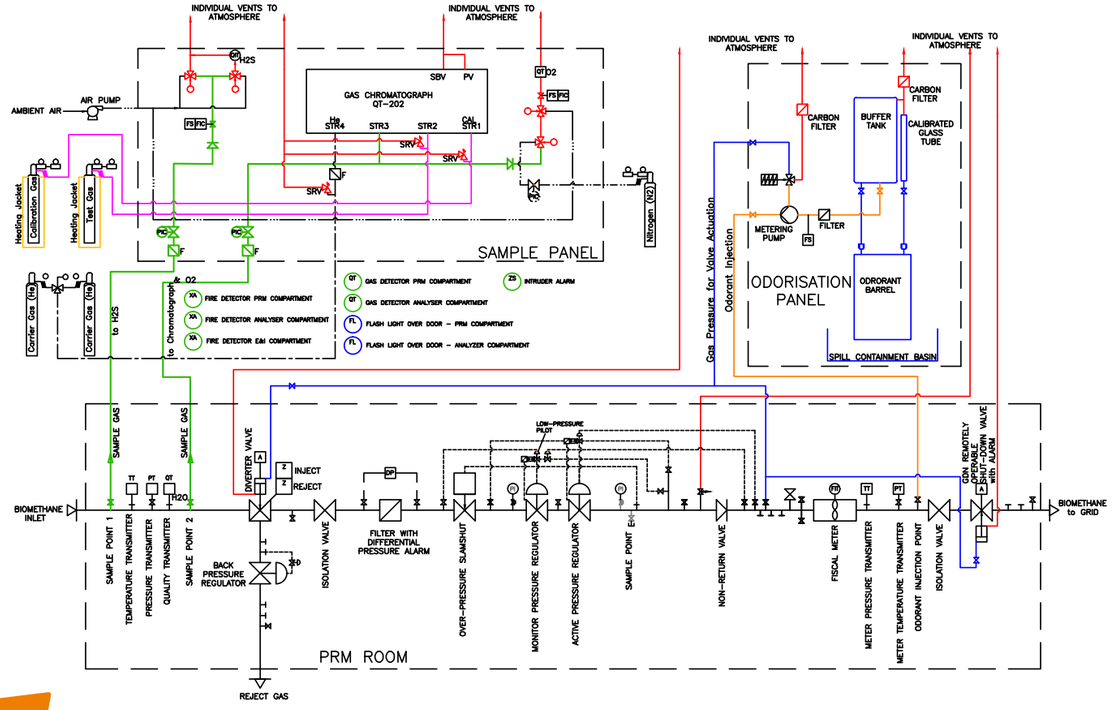
The rhinology point may or may not be within the site compound but appropriate access will need to be considered and designed in the site plan. The location needs to be selected so that the sample is solely representative of the biomethane and not the natural gas in the pipeline.

IGEM/TD/16 (see Section 10) gives further details of the requirements regarding odorant injection, but there may also be further, expansive standards set by the gas distributor.

7.1.6 Supervisory system

The BNEF supervisory system has to supply all relevant data to the distributers RTU in order that it can be supplied off-site to the Distribution Network Control System (DNCS) which controls the flow of gas into the gas network via the ROV.

The agreement reached in the GQ/8 workshop will detail the data collection requirements.



7.1.7 Generic BNEF pipe and instrumentation diagram

An output of the BNEF design process will be a pipe and instrumentation diagram. (PID). As an example, a standard BNEF PID may look like this but its design must meet the requirements of the NEA:

The drawing outlines details the equipment, pipework locations and the necessary valves within the BNEF.

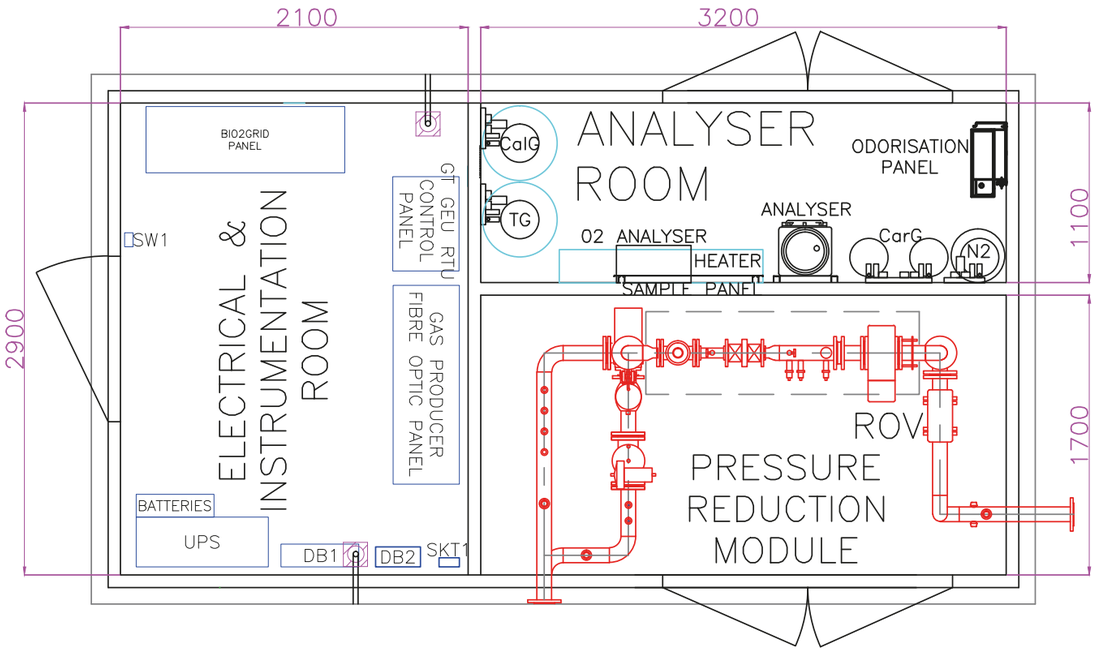
7.1.8 Generic BNEF layout general arrangement

A designer will produce a general arrangement plan drawing (GA) that will show the dimensions of the BNEF housing, the location of the pieces of equipment and the delineation of the spaces. This drawing shows how the installation will look in-situ.

Each BNEF installation is site specific and will need to be designed to reflect:

- Site conditions
- Site constraints
- The design solution (capacity and flows)
- The ownership model (maximum and minimum)

A typical GEU plan will look like this:



7.1.9 Typical control philosophy – minimum requirements

The control philosophy for the anaerobic digestion plant BUP and propanation is outside the scope of this handbook as it is site specific. The control philosophy of the anaerobic digestion plant and BUP plant will need to interface with the BNEF and ROV.

At a high level the overall control philosophy is straightforward:

- The AD plant, clean-up and propanation system produces biomethane that is compliant at the required flow and pressure
- A pre-requisite for gas to grid injection is the confirmation that the ROV open status is confirmed
- The BNEF system analyses the biomethane, supplying the necessary information to demonstrate compliance against GSMR and the Gas Thermal Energy regulations, which allows the diverter valve to pass gas to grid
- Should the biomethane be non-compliant the diverter valve alters position to direct flow to the reject pipeline and closes to prevent the gas being injected to the grid. Odorant injection would cease
- If the biomethane is non-compliant and is not being automatically rejected, the ROV will be closed on the intervention of the gas network (DNCS). The closed status of the valve will be received by the BNEF

The detailed control philosophy is to be developed to ensure non-compliant gas is not injected into the grid whilst maintaining safety of the entire facility.

Due regard should be given to system sampling and analysis loop times necessary for the installed equipment as this may increase the volume of non-compliant gas produced.

7.1.10 Telemetry data – minimum requirements

The following table gives the range of data that will be supplied to the relevant gas distributor, method of supply of data will be detailed in the NEA:

Characteristic	Unit	Permitted Range	Transmittal mode	Frequency
Mains Fail			Digital	Continuous
Calorimeter Alarm (System 1)			Digital	Continuous
Flow to Grid Valve Open			Digital	Continuous
Flow to Grid Valve Closed			Digital	Continuous
Reject Valve Open			Digital	Continuous
Reject Valve Closed			Digital	Continuous
Instantaneous Volume (F1)	MSCM/D	TBA	Analogue	Continuous
Integrated Volume	MSCM	TBA		Continuous
Slam Shut Alarm			Digital	Continuous
Outlet Pressure	barg	0-10	Analogue	Continuous
Oxygen	Mole %	0-1	Analogue	Continuous
Hydrogen Sulphide	ppm	0-10ppm	Analogue	Continuous
Total Sulphur	mg/CM	0-60	Analogue	Continuous
Incomplete Combustion Factor		-3.0 to 2.0	Analogue	Continuous
Soot Index		0-1.0	Analogue	Continuous
Inert Gases (including Carbon Dioxide and Nitrogen)	Mole%	0-10	Analogue	Continuous
Nitrogen	Mole%	0-10	Analogue	Continuous
Carbon Dioxide	Mole%	0-10	Analogue	Continuous
GS(M)R Compliance Alarm			Digital	Continuous
Meter Pressure	barg	0-10	Analogue	Continuous
Meter Temperature	°C	-10 to +40	Analogue	Continuous
Meter Suspect			Digital	
Hydrocarbon Dewpoint	°C at [27] barg	-20-10	Analogue	Continuous
Water Dewpoint	°C at [85] barg	-20-10	Analogue	Continuous
Carbon Dioxide	Mole%	0-10	Analogue	Continuous
CV	MJ/SCM	35-44	Analogue	Continuous
Relative Density		0.5-0.8	Analogue	Continuous
Wobbe	MJ/SCM	45-55	Analogue	Continuous
Other	As Appropriate	Dependant on Risk		

7.1.11 Periodic reporting

In addition to the telemetry requirements, the gas distributor will require periodic reports from the gas producer to demonstrate compliance with other determinants to those listed in the above table. The required information and frequency of reporting will be stated in the NEA and determined through a risk assessment.

The requirements for the information will be facility specific and will be determined by the feedstock that is to be used to produce biogas. For example, waste water sludge plants are likely to have siloxanes present and this needs very close monitoring.

Clause 5.6.5 of IGEM/TD/16 gives further information on the likely contaminants that may be present in biomethane (see Section 10 for more information).

7.1.12 HAZOP, HAZCOM, HAZCON

These are design tools that ensure that the necessary parties have had input into the procedural design of the scheme from an early stage. Outputs from this process will be required as part of the adoption procedure.

HAZOP

Hazards and Operability: this is a study that is undertaken on the design and infrastructure to ensure that all risks are minimised. It may be undertaken by an independent third party and should be completed as early as possible before the design is finalised.

HAZCOM

Hazards and Communication: the use of HAZCOMs is now standard within the gas industry and ensures that all parties are aware of the chemicals being used in a given process.

HAZCON

Hazards and Construction: this covers the hazards that may arise during the construction period of a given project. The producer may want to complete a HAZCON for their own internal processes.

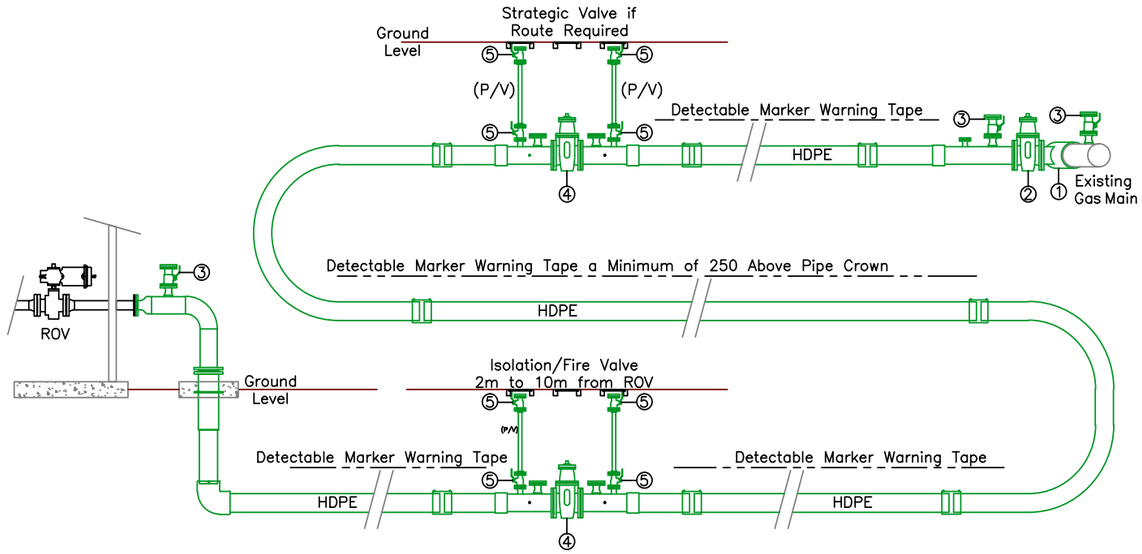
7.1.13 Telemetry

The distributor may require their remote telemetry unit (RTU) to be housed within a suitable location within the BNEF. The RTU will transmit all of the agreed data via satellite back to the control centre with an ISDN line acting as a secondary back-up route. A communications router is deployed to control switching between these routes and also allows access for the Gas Quality data to be transmitted via ISDN.

Confirmation of the data required will be recorded in the NEA.

7.2 Connection pipe

To transfer the biomethane from the BNEF to the grid, a connection pipe is required. A representation of a connection pipeline is detailed below. Note a bypass on the ROV is normally not required:



7.2.1 Remote Operating Valve (ROV)

The ROV is controlled by the gas distributor and is used to prevent gas that is not within specification from entering the grid. It is a 'gatekeeper' that should only be required if the BNEF has determined the biomethane to be non-compliant and the diverter valve has not gone into the rejected position.

The ROV is not to be used as the means of isolation for any maintenance work.

The ROV is to be compliant with the requirements detailed in the Gas Transporter's Minimum Functional Specification.

7.2.2. Gas compression

The biomethane gas will need to be injected into the grid at a pressure that correlates to the normal operating pressure in the downstream network. To achieve this, the gas is regulated to control the pressure at the point of injection.

The maximum flow rate of biomethane must be controlled by assets upstream of the BNEF and not solely by the BNEF pressure regulation and control system. As a precaution, the BNEF pressure regulation and control system should be fitted with a downstream over-pressurisation device, conforming to IGE/TD/13 that will protect the local gas distribution network.

The design for the mains connection and compressor can be undertaken by the producer's designers. The design should be appraised to meet the requirements of IGE/GL/5 Edition 2.

Further information on gas compression can be found in IGEM/UP/6 – Application of compressors to natural gas fuel systems. Note a compressor study is normally undertaken to develop the design.

7.2.3. Reject gas pipeline

The BNEF will periodically determine that the biomethane produced is not compliant. The reject gas pipeline must be sized to carry the reject gas safely away from the injection pipeline. The reject gas is then conveyed back to the anaerobic digestion plant and/or flare.

7.3. Plant redundancy

There is no requirement for any of the equipment in the BNEF and odorant plant to have any plant redundancy or standby equipment. The decision on this is for the gas producer to make; if the biomethane cannot be shown to be compliant it cannot be injected and there will be the consequential loss of gas to grid. Therefore, careful consideration needs to be made in this area as loss of revenue could be experienced.

7.4. Access requirements

7.4.1. Access for – inspection and maintenance

Pedestrian

All equipment owned, or adopted, by the gas distributor has to be accessible for operatives. All walkways need to be hard non-slip surfaces and free draining.

Vehicles

Vehicle access needs to be provided to within a reasonable distance of the equipment that is to be inspected, maintained or repaired.

Roadways need to be hard surfaced to a suitable strength to allow appropriate vehicles access and suitably sized turning areas.

7.4.2. Third party access

The distributor will require a level of access to the producer's site and plant. This needs to be agreed, recorded and permitted. Access will also be required by the Gas Examiner and any parties undertaking an independent technical audit.

7.4.3. Security

Site specific security operational requirements are to be captured by the gas distributer. This will determine the security measures and standards to be implemented on site.

Double locking arrangements

The biomethane facility site needs to be provided with a double locking arrangement, or other suitable arrangements, to enable the distributor to access equipment under their control at all times.

Restricted Areas

The area enclosing the Remote Operated Valve, RTV and odorant equipment of the production facility will be secured at all times and access restricted to prevent entry by any person other than those approved by the gas distributor. There should be appropriate access restrictions to all panels.

8

Documentation

This section contains an overview of key documents and standards associated with the biomethane connection process, including:

- **Network Entry Agreement (NEA)**
- **Construction Agreement**
- **Adoption Agreement**

8.1 Connection Reservation

To be able to secure a connection, the biomethane producer's team must have completed:

- A successful initial capacity study
- A successful detailed capacity study
- A detailed design study or validation on the BNEF
- A detailed design study or validation on the ROV, export pipe and the odouriser
- All of the necessary paperwork required to support the Connection Reservation Application. This will include the planning application details, land lease/purchase details, third party access rights, funding status, etc

8.2 Network Entry Agreement

The Network Entry Agreement (NEA) is the authorisation given by a gas distributor to a biomethane producer for accessing the gas network. The agreement will detail the conditions, limitations and rules regarding the entry.

The first step to securing an NEA is the successful completion of a GQ/8 workshop and the HAZOP (see Section 7 for further details). The gas distributor will then commence an internal process for getting a draft NEA to the producer's solicitors. There are likely to be negotiations around the technical contents of the NEA and appropriate time will need to be allowed for the completion of this document.

The NEA will contain a schedule of agreements that will need to be met by the producer and transporter, which ensure that the producer's plant and equipment is fit to provide biomethane in accordance with the conditions stipulated in the NEA. This will include:

- Written Scheme of Examination
- As-built drawings, diagrams and specifications
- Safe Operating Limits
- Maximum Operating Pressure
- Gas quality requirements including the required calorific values for the gas

See Section 10 for a fuller explanation of each of the above.

The main body of the agreement document will consist of nine schedules:

Schedule 1 – System entry point

Within this schedule, there will be a diagram of the process for the grid entry. The diagram will show the process for treating the gas and the associated ownership of equipment. There will be a grid reference to confirm where the location of the entry point is.

Schedule 2 – Contractual flow rates

There may be limitations and parameters on the supply of gas into the network. The predominant figure will be the maximum supply volume, usually expressed in standard cubic metres per hour (scm/hr). This will be agreed to ensure that the network mains are not exceeding their volume capacity. Similarly, there may be a minimum supply agreement. However, it is often agreed that this can be zero.

It should be noted that, during peak low demand periods, the network may not be able to accommodate all of the maximum flow rate.

Schedule 3 – Plant, equipment and ownership

The plant and equipment utilised within the process is detailed in a diagrammatical form. This diagram will also reflect the associated ownership of the equipment.

Schedule 4 – Network entry provisions

The contents of Schedule 4 will define the quality of the gas being put in to the system. It will explicitly detail the maximum limits of the gas constituents and will define the characteristics of the gas (temperature, water content, calorific value, odour, etc) It is critical that all of these criteria are met or the gas will be rejected by the BNEF.

The distributor risks large fines if the gas injected into their networks is not of the correct calorific content. To ensure that this does not happen, the energy content is calculated and monitored by the BNEF.

Schedule 5 – Measurement provisions

Schedule 5 is very detailed and covers the measurement requirements within the facility. It spells out the installation, commissioning and maintenance requirements of the measurement equipment. It will also detail the permitted tolerance factors for the measurement equipment.

Schedule 6 – Local Operating Procedures

Under the Network Entry Agreement, the approved Local Operating Procedure is captured under Schedule 6. All parties need to be aware of their duties in this agreement. The schedule covers the communication required between all parties on issues such as flow rates, Calorific Value ratings, operations and maintenance schedules.

The schedule will also include the pro-forma templates that must be completed.

Schedule 7 – Expert determination

This schedule confirms that all Provisions of Section GTA1 of the Network Code will be adopted apart from any amendments explicitly detailed in the schedule.

Schedule 8 – Accession agreement

This schedule is provided for the signatories to the Network Entry Agreement document.

Schedule 9 – The Delivery Facility and the Entry Facility

Under Schedule 9, there will be clarification on the equipment owned by the producer and transporter.

8.3 Construction agreement

The construction agreement will be available via the gas distributor's website. This agreement exists between the distributor and the producer and details the terms and conditions for the construction work. The document will also include costs for commissioning, the physical works, and end-to-end testing.

The construction agreement can only be progressed once the ownership of the plant has been agreed. This is described as the 'minimum/maximum connection model' (see below to a fuller explanation).

8.4 Adoption agreement

When a producer has completed the construction of their plant, some of the infrastructure will be adopted by the distributor. The level of adoption is dependent on the distributor's requirements (called the 'minimum/maximum connection model') but it is likely to include the ROV, the export pipe, the RTU and the odouriser.

If the distributor undertook the network connection works, only the Utility Infrastructure Provider (UIP) and the distributor will need to sign adoption agreements for the minor items of works not done by the distributor.

If the UIP has done all of the network connection works, two agreements will need to be signed, one with the UIP and one with the producer.

To ensure that the adoption is processed in line with all regulatory standards the producer needs to be familiar with IGEM documentation (IGEM/TD/101 Ed 2) and the distributor's own internal documentation (which is likely to be based around IGEM/TD/101 Ed 2). By following all of the necessary protocol and procedures, the producer will make the adoption process considerably easier and quicker.

If the producer has progressed the design works with a UIP, they must process all necessary documentation, including a Non-Routine Operation form (NRO), to enable the distributor to adopt the export feeder main. The documentation should include any easements.

The appropriate contact will deal with final sign-off for the Remote Telemetry Unit. This will need to be supported by a telemetry Non-Routine Operation document.

It is essential that the producer has completed and compiled all the necessary paperwork and certification to be checked and included as part of the Gas Transporter's Validation and Adoption procedures. Particular attention should be paid to the requirements detailed for the FWACV and Letter of Direction (Ofgem), Design Pack appraisal and reviews, Material and Test Certification Maintenance Manuals, Site Specific access, contact details, emergency plans, stakeholder management plan and any other requirement to comply with legislation and Northern Gas Networks' requirements.

8.5 Design services agreement

A design services agreement will be required when the distributor is instructed to undertake design of the ROV, export pipe and the mains connection on behalf of the producer. The appointment of the distributor to undertake the design is optional for most schemes.

8.6 Minimal functional spec for BNEF

Within the documentation on the distributor's website, it is possible to obtain a guide to the minimum functional specification for a BNEF. This document will give guidance on the specification and performance for the BNEF but is not a definitive design specification as designs may change on a site by site basis.

8.7 Local operating procedure

The DFO and DNO will need to agree local operating procedures for the provision of Gas Flow related information to each other so as to facilitate the safe and efficient day-to-day operations of the BNEF. These procedures are site specific and will detail exactly how the plant will operate. This will allow any technical personnel visiting the scheme to understand the procedures for any part of the plant.

8.8 Letter of Direction by Ofgem

This letter will inform the producer of the 'gas-on' date and the agreements on the manner and location for determining the Calorific Values. It will also spell out the operational requirements for the CV analyser.

8.9 FAT and SAT on BNEF

FAT is the Factory Acceptance Test and SAT is the Site Acceptance Test. These are commissioning tests that are executed on the BNEF installation.

Note one key deliverable is the RTU Input/Output mapping matrix. This must be provided to the DNO in good time to support the creation of data transfer systems between DNO and the National Grid (UKT). This should be issued as a final version no later than ten weeks prior to the 'gas on' date.

Essentially the FAT enables components that make up the BNEF to be tested. The SAT is a 'multi-layered' procedure that tests elements of the equipment after installation and ultimately demonstrates that the components interact to provide a fully functioning process.

It is necessary to invite the gas distributor to both the FAT and the SAT so that they can witness the necessary testing. The gas distributor may attend the FAT but will definitely attend the SAT.

9

Construction & Commissioning

This section contains information about the construction, ownership and commissioning of key pieces of equipment including:

- **Anaerobic Digestion Plant**
- **Biomethane Network Entry Facility and associated housing**

9.1.1. Anaerobic Digestion plant

General

The first piece of plant to be constructed will be the Anaerobic Digestor (AD). Some producers may already have this plant in place, of course, and need only focus on the equipment needed to convert the biogas into biomethane.

A producer that requires a new AD plant will have a variety of suppliers willing to provide their services. It is recommended that producer uses a supplier that knows the UK regulatory market and has previously delivered similar schemes.

9.1.2 Plant Commissioning

The commissioning of the AD plant will need to cover:

- All of the mechanical and electrical installation
- Formal calibration and sign off of the fiscal metering system
- The completion of all the SAT testing
- Performance and reliability assessment
- The necessary training for the producers and, where appropriate, the distributor's staff
- Ongoing assessment of improvement, with a view to improving performance
- Necessary HAZOP workshops to ensure that safety is considered throughout the production process

9.2 BNEF

9.2.1 General Requirements

The installation, testing and commissioning of the BNEF is likely to be more technical than the AD equipment, due to the regulatory requirements imposed on the distributor.

Because of the technical nature of a BNEF, a lot of manufacturing is executed off-site, in factory conditions. This clean environment will allow all of the sensitive, fragile equipment to be fitted, tested and commissioned to the necessary standards. Once the equipment has passed the factory testing, it will be certified with a FAT. This will allow the equipment to leave the factory for installation.

Whilst the BNEF is assembled and tested in the factory, the site will be prepared for the delivery of the BNEF. The site works will include:

- Pouring a reinforced concrete slab for the BNEF to sit on
- Provision of the necessary gas and electricity infrastructure to run the plant
- Construction of any necessary vehicular access routes
- Installing the necessary infrastructure for telemetry and communications with the distributor
- Construction of the gas export pipe

When the BNEF receives the FAT and the site works have progressed to a suitable stage, the BNEF will be transported to site and located into position. The BNEF will then be connected to all of the necessary

infrastructure (electricity, communications, gas, pipework, etc). Once connected to the rest of the plant, the equipment within the BNEF is tested again. This is called a SAT (Site Acceptance Test) and is undertaken for two reasons:

1. To ensure that none of the sensitive equipment has been damaged in transportation
2. To ensure that the equipment is performing in 'real-life' conditions as opposed to the more clinical conditions of the factory

There should be a documented list of physical checks that need to be undertaken as part of the FAT and SAT tests. These should be supported by associated dates. This schedule of dates and checks should be issued to all parties so that they have the opportunity to attend.

Once installed on site, there will be physical checks at the completion of the construction, including off-line calibration and validation of the metering, the telemetry and Xoserve. The metering system will need to be validated in accordance with ME/2. ME/2 is a gas distributor procedure that is used to demonstrate that instrumentation and equipment associated with measurement systems for the calculation of mass, volume or energy flowrate of gas are functioning correctly thus ensuring that the complete metering system continues to perform within the uncertainty requirements, and also with independent audits completed by a United Kingdom Accreditation Scheme (UKAS) accredited organisation. There will need to be end-to-end testing of all signals to and from the DNCS, as well as live tests of the divert process and ROV.

As part of the commissioning exercise, there will need to be confirmation with the distributor and Ofgem on the odorant rhinology test point.

There will need to be written agreements about the maintenance schedule that cover both the producer's responsibilities and the transporters' responsibilities. The schedule should also include the necessary list of spares, suppliers and specifications. This should be supplemented with the associated lead-in times for the procurement of the spares.

The BNEF housing

The design and construction of the housing for any equipment, including the BNEF, must follow all appropriate building regulations and codes (including the Minimum Specification Requirements). The building must feature explosion relief roof above hazardous area compartments, all necessary weather proofing, drainage and guttering; and opening outward doors fitted with door stays, handles, locks and magnetic switches to indicate that the door is open. The doors, when open, must withstand the load from 80 mph winds.

The building must be suitably sub-divided to house the gas analysis equipment, bottle stores, odourisation equipment and the BNEF/distributor control equipment. Internal dividing walls must be sealed (gas tight) so that hazardous area zoning is maintained (specifically safe areas are not compromised). Any ventilation to a compartment must be directly to the outside of the kiosk and not to another kiosk compartment. This applies also to forced ventilation.

The producer must provide suitable housing for the calibration gas bottles and the gas analyser equipment, including appropriate heating for the space (including jacket heating for the calibration and test gas bottles) to ensure a temperature range of 15ºC – 40ºC. Subject to any supplier recommendations, as a minimum, this housing must achieve the same environmental requirements as the telemetry system. Additionally, the design of this building must achieve safe and unobstructed movement of the calibration bottles into and around the building.

9.2.2 Commissioning by the gas distributor

To understand the commissioning requirements of the gas distributor, producers should ensure that they have consulted:

- IGE/GL/5 Edition 2 'Procedures for managing new works, modifications and repairs'
- NGN/PM/G/17 'Management Procedure for the Management of New Works, Modifications and Repairs Incorporating Commissioning, Operational and Asset Compliance'

The documentation indicates that the producer must assess the project for the level of risk and categorise it as low, medium or high. Once this has been categorised, there is guidance on the design requirements for adoption to take place.

The BNEF installer will need to provide suitable training to the distributor's operatives who will be responsible for the operation and maintenance of the ROV, odorant plant and the RTU.

The gas distributor will sign-off the G/17 approval to commission before allowing gas to flow.

Subject to all the commissioning checks listed above, including the validation and handover, the distributor will now agree that gas can be exported into grid. Alongside the training, operation and maintenance, manuals will need to be provided at handover as well as contact lists covering the distributor users, BNEF manufacturers and the producer's employees.

All personnel carrying out commissioning and initial validation must be competent and adequately trained to do so.

A written pre-commissioning/commissioning Non-Routine Operation (NRO) procedure must be used for all activities. Initial metering validation must be carried out in order to demonstrate the accuracy of the measurement system.

Suitable systems, software or procedures must be provided or agreed to ensure that compliance can be demonstrated.

9.2.3 Operation and maintenance manual (O&M manual)

It is a legal requirement (under the CDM Regulations) that all new building work must be supported by operation and maintenance manuals (O&M manuals). To comply with legislation and contractual obligations, all equipment maintenance and hardware manuals must be supplied before site commissioning. Generally, the completion of the O&M manuals will be completed by the engineer, procure and construct contractor.

The O&M manuals will detail everything from cleaning, maintenance procedures, replacement periods through to registered suppliers and points of contact.

10

Regulations and Standards

This section outlines the regulations and standards that must be met when producing biomethane.

10. Regulations and Standards

There are a significant number of regulations and standards that must be met when producing biomethane. The producer will need to review a variety of material, including:

- Acts
- Regulations and Orders
- European Legislation
- HSE Approved Codes of Practice and Guidance Notes
- Institution of Gas Engineers and Managers (IGEM) documentation
- British Standards
- Gas Industry Standards

Although not an exhaustive list, the following covers the main technical and legislative documents.

The following documents are specific to NGN or industry standards compiled by IGEM, the Institute for Gas Engineers and Managers. You will be able to obtain full versions of the documentation from IGEM **(www.igem.org.uk)**.

IGE/GL/5 Edition 2 – Procedures for Managing New Works, Modifications and Repairs

The GL/5 documentation covers the management of new works, modifications and repairs undertaken on the UK gas network. A producer will need to comply with this procedural document as their plant will be connecting into the gas network.

The completion of all the GL/5 documentation can be labour intensive and requires expert guidance. The sign-off for documentation needs to be completed by an appraiser who is instructed by the producer. This needs to be done for each element of the works (telemetry, electrical, instrumentation, etc).

Gas producers are guided towards Appendix F of the GL/5 documentation as this gives a detailed breakdown of what information will be required from the Utility Infrastructure Provider (UIP)/producer to successfully conclude the GL/5 documentation. The contents of Appendix F include:

- Drawing scales
- Qualification requirements of UIP staff
- Equipment sizing
- Risk assessment requirements

NGN/PM/G/17 – The Management of New Works, Modifications and Repairs incorporating Commissioning, Operational and Asset Acceptance

The G/17 documentation covers the management of new works, modifications and repairs incorporating commissioning, operational and asset acceptance and is a necessary requirement for any infrastructure that will be adopted in the future by the gas distributor.

The completion of all the G/17 documentation can be labour intensive and needs coordination by a subject expert. The sign-off for documentation needs to be completed by both an approver and an appraiser who will be instructed by the producer. This needs to be done for each element of the works (telemetry, electrical, instrumentation, etc).

NGN/PM/GQ/8 – Management Procedure for Assessing the Requirement for Gas Quality, Calorific Value and Flow Measurement Systems

This is a gas quality workshop that forms part of the risk management strategy. The workshop can be organised by the gas distributor or the designers appointed by the producers.

NGN/SP/ME/1 – Specification for Gas Transporter's Requirements for Gas Measurement Systems Connected to the NGN Network

This is the specification for the gas transporter's requirements for gas volume and energy measurement systems connected to the National Grid Gas Transmission and Distribution Systems. It dictates how the gas should be measured and the standard of equipment required to achieve the measurement.

NGN/PR/ME/2 – Validation of Equipment Associated with the Calculation of Mass, Volume and Energy Flow Rate of Gas

These are the procedures that will demonstrate that the instrumentation and equipment used within a facility performs to the required standards. There are five parts to this procedural document but only the first three will be relevant to a producer:

- Part 1: General Requirements
- Part 2: Generic Test Procedure
- Part 3: Flow Weighted Average Calorific Value Offtakes

IGE/TD/4 – Edition 4 – Polyethylene and Steel Gas Services and Service Pipework

These are recommendation guidelines that cover the design, construction, inspection, testing, operation and maintenance of gas services infrastructure.

IGEM/TD/13 – Edition 2 – Pressure Regulating Installations for Natural Gas, LPG

This technical standard covers pressure regulating installations for transmission and distribution systems.

IGEM/TD/16 – Biomethane injection

This standard is crucial to a producer as it covers the construction and operation of facilities that allow biomethane to be injected into the UK grid. It details the requirements for design, construction, installation, inspection, testing and operation of a Biomethane Network Entry Facility (BNEF). It should be noted that the Biomethane Upgrading Plant (BUP) is outside of this standard.

IGEM/TD/17 – Steel and Polyethylene pipelines for Biogas Distribution

This technical standard covers biogas pipelines. It will primarily be used by the gas distributors and the gas producer's team to work to.

IGEM/TD/101 Edition 2 – Adoption of pipe systems by a Gas Transporter – management of Utility Infrastructure Provider activities

This document will cover the requirements for laying newly constructed gas mains and services and details what needs to be achieved by the UIP for the distributor to adopt the pipe systems.

Other documents include:

Uniform Network Code – UNC

This is a set of rules that allow competition within the gas network whilst ensuring consistency and assurance.

HSE's RR882 Research Report – Hazards arising from the conveyance and use of gas from Non-Conventional Sources (NCS)

This document helps the Health and Safety Executive (HSE) to undertake assessment of hazards and risks associated with the introduction of Non-Conventional Source (NCS) gas into the existing national gas pipeline network. It provides guidance, procedures and processes to ensure compliance and the continued safe operation of the gas network.

Gas Safety (Management) Regulations 1996 – GS(M)R

This document addresses the compliance requirements on the installation, operation and maintenance for conveying gas within the UK network.

The regulations include Generic Gas Quality in Schedule 3. This will inform a producer of the gas quality that will need to be achieved. However, minor exemptions have been negotiated from the regulations on the O_2 content – the HSE has granted a class exemption to permit gases containing up to 1% mol/mol into transmission and distribution systems, up to 38 bar, provided that the gas is otherwise compliant with GS(M)R.

Gas (Calculation of Thermal Energy Regulations) 1996 (Amended in 1997 and 2002)

This regulation dictates the necessary calculations and definitions required to ensure that the Flow Weighted Average Calorific Value (FWACV) requirements are being met.

Pressure Systems Safety Regulations 2000 – PSSR

PSSR apply to all pressure systems where the relevant fluid is at a pressure greater than 0.5 bar above atmospheric pressure. In the context of this document biomethane, being transported at a pressure >0.5 bar over atmospheric is considered a relevant fluid.

Pipeline Safety Regulations (PSR) 1996 & Pipeline Safety (Amendment) Regulations 2003 – PSR

The PSR apply to all pipelines and require that they are designed, constructed and operated safely. This will include examination and maintenance. The Biomethane Network Entry Facility, in addition to the rest of the production facility, has to be designed in accordance with these regulations.

The Dangerous Substances and Explosive Atmospheres Regulations 2002 – DSEAR

A hazardous area drawing is required to be produced under DSEAR. This may affect the location and layout of the biomethane production facility and proximity to properties and potential ignition sources.

Each piece of equipment in the Hazardous Area within the BNEF (such as the Pressure Reduction Module and Analyser rooms) needs to be suitable for use in the specified hazardous location.

Construction (Design and Management) Regulations 2015 – CDM

Under CDM 2015, a biomethane producer wishing to connect to the grid has to appoint a principle designer for the work. Within the scope of the work to be undertaken by the principle designer there is a requirement for the Biomethane Network Entry Facility and the Remote Operable Valve to be included. The producer has to ensure that the principle designer's brief includes any work associated with this equipment.

Transporter's Minimum Functional Specification

This specification is a comprehensive overview of requirements from the gas distributor. It details the minimum requirements for vital pieces of equipment including the Remote Operating Valve, the metering, the Analyser and the housing. This document will also explain where responsibilities lie between the producer and the distributor. Whenever a producer wishes to inject into the grid, they will need to show that they have complied with these requirements. The Minimum Functional Specification document will also contain a detailed schedule of reference documents.

11

Producer Tips

In this section, biomethane producers from around the UK share their feedback from recent projects, including their top tips and challenges.

11. Producer Tips

1. **Individual contractors vs. single 'turn-key' solution:** by appointing different parties for individual elements of the works, a producer had five – six contractors to oversee and to contract with. This could have been avoided if the appointment had been made with a single turnkey contractor. The producer also noted that packaging the detailed design elements into the turnkey contract could have also saved time.
2. **Minimum vs maximum connection options:** the minimum and maximum connection options have different costs and may have different programme implications.
3. **Network Entry Agreement (NEA) timescales:** one producer noted that the NEA took a long time to close out, but this was partly due to the new exposure to the process for the distributor.
4. **Gas quality failure:** when there is a failure of gas quality detected by the BNEF, two successful samples must be taken before gas is allowed to be injected again. Some accredited gas sampling equipment works on four minute cycles. That would mean that there would be over eight minutes of gas rejection before re-injection is permitted. An analyser on a continuous cycle may decrease the injection period.
5. **Sourcing equipment from overseas:** as the biomethane market in the UK is still in its infancy, certain products and services are regularly being imported from more established markets. Prior to placing orders and contracts it is important to ensure that all components and services meet the relevant UK standards and regulations.
6. **Impact of third party actions:** third party actions can have a big impact on a producer's programme. For example, one producer gave the example of a phone line taking around 12 months to install. Be aware that something as incidental as installing a phone line can have a significant impact on your project timeline so make sure you consider this at the outset of your project.
7. **Importance of applying for planning permission early:** planning permission for the biomethane facility needs to be progressed early, to ensure there are no unforeseen issues. For example, there may be planning constraints on the height of plants which could affect the scrubber in the biomethane upgrade plant (BUP).
8. **Regular meetings with the gas distributor:** there are distinct benefits to be gained from holding regular meetings for the producer and transporter. The meetings allow the coordination of tasks as well as clarity regarding roles and responsibilities and effective data sharing between the parties.
9. **Gas examiner's availability:** one producer noted that securing the involvement of the independent gas examiner was difficult, as their availability is limited. Making early contact is therefore essential.
10. **GQ8 workshop attendees:** the distributor's gas quality representative should attend the GQ/8 workshop. Ensuring the right representatives are present can be critical to the success of the scheme.
11. **Organise the HAZOP early:** the HAZOP can require a considerable amount of organising, due to the number of attendees. The arrangements for this exercise should be started as early as possible.
12. **G/17 complexity:** the extensive paperwork required to close out G/17 proved more labour intensive than anticipated for one producer. It was observed that it would have been beneficial to have an employee who had the direct task of document control (potentially the Project Manager) throughout the G/17 period. Similarly, another producer suggested it would have been better to go to the gas distributor for appointment of a designer to agree the paperwork for the G/17.
13. **Variations in standards:** there may be slight divergence on the ME/1 and ME/2 and G/17 and G/19 by all the different distributors. It is therefore critical for a producer to ensure that the correct documentation is being referenced and adhered to.
14. **Dual streams could be a more cost effective option:** a producer should consider redundancy/dual streams and duty standby equipment, to provide a back-up solution in the event of equipment failure. There has been recorded instances of production/injection being compromised due to the failure of minor pieces of equipment. Low cost duty/stand-by equipment would overcome this and the cost of not injecting could well be higher than the cost of maintaining standby equipment. For example deploy two odorisation pumps not one.
15. **Maximum Operating Pressure:** make sure this detail is in the initial enquiry and the NEA.
16. **Operation and Maintenance (O&M) manuals:** one producer found that the production of the O&M manuals was a protracted process. Where parts of the plant are being adopted by the distributor, the relevant parts of the O&M manuals must go to the transporter for the adoption to be complete.
17. The time spent undertaking the Factory Acceptance Testing (FAT) has been compromised due to on site constraints. This did not necessarily compromise the project but the preference would always be to allow a minimum of two days to get the FAT satisfactorily completed.
18. **Early receipt of the Construction Agreement is helpful:** the producer will benefit from receiving the Construction Agreement as early as possible so that they can review costs and timescales.
19. **Rhinology test location:** the location of the Rhinology point can be a contentious issue. This should be considered from an early stage.
20. **The importance of a good project manager:** to manage a gas to grid scheme requires an experienced Project Manager, with specialist knowledge.
21. Sufficient time needs to be included in the programme for third party approvals.
22. **Off-site telemetry:** establishment of off-site telemetry has been found to be a time consuming task due to the complexity of the required system and number of parties that require liaison. The design needs to be progressed and agreement of the information control system reached.
23. **Biomethane compliance:** the effects of each stage of the gas production process, such as gas clean up and water content removal, needs to be carefully considered, so that the resulting biomethane is compliant with regulations.
24. There were considerable benefits experienced from getting good advice on the waste stream and what quality it will be at the end as it will impact. It is important to understand the waste product and how to get rid of the by-product early on.
25. **Impact of feedstock seasonality:** the seasonality of the feedstock will affect the digestates and can also affect the quality and quantity of gas production.
26. The site has had to manage the CV position whilst not compromising Wobbe, Sooting Index or other related Gas Quality values.

12

Glossary of Terms

This section includes a list of explanations for commonly used acronyms and technical terms to help simplify the jargon.

12. Glossary of Terms

AD – Anaerobic Digestion

ADBA – Anaerobic Digestion & Bioresources Association

Biogas – Mixture of gases produced by anaerobic digestion

BNEF – Biomethane Network Entry Facility. This is an element of plant that facilitates the gas injection into the grid. The plant is a specialist piece of equipment that odourises and pressurises. Also known as GEU

BUP – Biogas Upgrading Unit CHP – Combined Heat and Power CV – Calorific Value

DESNZ - Department for Energy Security and Net Zero. A ministerial department responsible for ensuring that the country has secure energy supplies that are reliable, affordable and clean.

DFO – Delivery Facility Operator

DNCC – Distribution Network Control Centre

DNCS – Distribution Network Control System

DNO – Distribution Network Operator

FAT – Factory Acceptance Test: this is a commissioning test, executed on the BNEF equipment at the point of factory production

Feedstock – A source of waste organic material that can be used in the anaerobic digestion process.

The efficiency of methane extraction is dependent on the organic material being processed – there can be large differences to the level of methane produced from different materials

FWACV – Flow Weighted Average Calorific Value

FiT – Feed in Tariff: a UK Government incentive brought in to support the production of energy by small scale renewable projects

GEU – Grid Entry Unit

GDN – Gas Distribution Network

GNCC – Gas Network Control Centre

HAZOP – Hazards and Operability: this is a study that is undertaken on the design and infrastructure to ensure that all risks are minimised

HPMIS – High Pressure Metering Information System

Incentive Scheme - The current incentivisation programme run by DESNZ, a government funded body.

NEA – Network Entry Agreement

Ofgem – The Office of Gas and Electricity Markets: this is a non-ministerial regulator that runs the UK's gas and electricity networks

PSSR – Pressure Systems Safety Regulations: these regulations cover any pipework or infrastructure that works under pressure. It has been designed to mitigate explosions and failures within pressurised systems

ROV – Remotely Operated Valve

SAT – This is the Site Acceptance Test: these are commissioning tests that are executed on the BNEF installation, on site

UIP – Utility Infrastructure Provider

Xoserve – A third party company that provides centralised information and data services for gas transporters and shippers

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