ofgem

RIIO NIC NETWORK INNOVATION COMPETITION

Project Code/Version Number:
NGGDLGN04/1

1. Project Summary

1.1. Project Title	Future Billing Methodology
1.2. Project Explanation	This Project explores options for a fair and equitable billing methodology for the gas industry which will be fit-for-purpose in a lower-carbon future. It aims to integrate diverse gas sources without needing to standardise energy content and will inform the industry on billing options for a sustainable gas future.
1.3. Funding licensee:	National Grid Gas Distribution Limited
1.4. Project description:	1.4.1. The Problem(s) it is exploring Great Britain (GB) has relied on North Sea Gas since the 1970s with regulations and billing regimes designed for this stable and reliable source of gas. The supply market is changing rapidly with liquefied natural gas (LNG) imports making up 18% of supply in 2015. By 2030 biomethane and bio-substitute natural gas from a large number of sources could account for 10% of domestic gas usage. The current Flow Weighted Average Calorific Value (CV) billing regime may restrict entry to unconventional gases that comply with Gas Safety (Management) Regulations, GS(M)R. Additional, expensive processing is required to match the CV of the primary inputs. The Project explores options for assigning CV at a more specific level, to avoid processing, and could provide a more robust attribution of gas energy to customers generally for decades to come. 1.4.2. The Method(s) that it will use to solve the Problem(s) Three scenarios will be explored using measurement, network modelling and smart meter data transfer following industry engagement: **Scenario** / **CV measurement**: 1. – '*Pragmatic*' – Entry only 2. – '*Composite*' – Entry and within network 3. – '*Ideal*' – Consumer meter 1.4.3. The Solution(s) it is looking to reach by applying the Method(s)

	Recommend a revised energy assignment methodology that is robust and equitable to consumers and industry stakeholders to meet future needs. 1.4.4. The Benefit(s) of the project The project aims to recommend a revised billing methodology to deliver these benefits: • Promote entry of all GS(M)R compliant low carbon and unconventional gas supplies anywhere in the network. • Enable gas transporters to accept GS(M)R compliant gases without processing. • Reduce CV shrinkage on the NTS. • Increase fairness of consumer billing by more accurately attributing the CV. • Ensure the longevity of the gas network for delivering energy for space and water heating. • Support the GB rollout of other NIC projects. • Reduce/eliminate the requirement to manage CV in the NTS and gas distribution networks. • Facilitate the decarbonisation of gas. • Minimise cross-subsidy between consumers.

1.5. Funding

1.5.1 NIC Funding Request (£k)	£4,799k	1.5.2 Network Licensee Compulsory Contribution (£k)	£538k
1.5.3 Network Licensee Extra Contribution (£k)	0	1.5.4 External Funding – excluding from NICs (£k):	0
1.5.5. Total Project Costs (£k)	£5,381k		

1.6. List of Project Partners, External Funders and Project Supporters (and value of contribution)	Project Partners: DNV GL External Funders: None Project Supporters: National Grid Gas Distribution Limited and DNV GL

1.7 Timescale			
1.7.1. Project Start Date	1st April 2017	1.7.2. Project End Date	31st March 2020

1.8. Project Manager Contact Details			
1.8.1. Contact Name & Job Title	Andy Lewis Project Delivery Specialist, Network Innovation	1.8.2. Email & Telephone Number	andy.lewis@nationalgrid.com 01455 892 524 07970 831 058
1.8.3. Contact Address	National Grid Gas Distribution, Brick Kiln Street, Hinckley, Leicestershire, LE10 0NA		

1.9: Cross Sector Projects (only complete this section if your project is a Cross Sector Project, ie involves both the Gas and Electricity NICs).	
1.9.1. Funding requested the from the [Gas/Electricity] NIC (£k, please state which other competition)	N/A
1.9.2. Please confirm whether or not this [Gas/Electricity] NIC Project could proceed in the absence of funding being awarded for the other Project.	N/A

Section 2: Project Description

2.1. Aims and objectives

National Grid Gas Distribution is the licensed owner and operator of four of the eight gas distribution networks in Great Britain: East of England, London, North West and West Midlands. Gas is transported, on behalf of Shippers and Suppliers, from the gas National Transmission System (NTS) and on-shore gas production facilities to approximately eleven million meter points comprising homes, schools, hospitals, industrial and commercial premises.

As a gas transporter, the primary duties under the *Gas Act* (1996) are to develop and maintain an economical and efficient gas transportation system and, subject to this, respond to reasonable requests for connection to the pipeline system. Under the charging terms of the licence, changes to the gas transportation business must also be taken into account.

This Project bid for the Gas Network Innovation Competition (NIC), seeks to provide a "proof of concept" for options to develop a future billing methodology that could facilitate a sustainable, cost-efficient and low-carbon future Gas Distribution regime.

Unlike electricity, gas must be measured first in volume terms and then have its energy content assigned. This Project seeks to explore the ways in which the energy content of the gas could be assigned reliably at a more specific level than under the present flow-weighted average calorific value (LDZ FWACV) approach. This can be done either by identifying the "zone of influence" exerted by a given input point within the Local Distribution Zone (LDZ) under varying system conditions, or ideally at meter point level.

The Project aims to provide essential groundwork that will inform the industry on options for future changes to billing methodology. Changes that would better support the wholesale transportation of gas from diverse sources including biomethane from anaerobic digestion and bio-synthetic gas (both recycling waste), together with other sources such as indigenous shale gas, or LNG, whilst removing the need for expensive additional processing such as adding propane or nitrogen to standardise energy content. It will help to realise the true low-carbon benefit of low CV gases and could also support the deployment of hydrogen in the Gas Distribution grid, where practicable.

The ultimate aim of the Project is to provide the key enabler for a sustainable cost-efficient, low-carbon means of fuelling domestic and commercial space heating. It will promote the continued use of the gas grid, returning benefits on existing investment by gas consumers, to provide an economic alternative to the costly re-engineering of the electricity supply chain.

The billing methodology needs to be applicable for implementation across Great Britain (GB) and facilitate the entry of all gases into the supply network that are compliant with the Gas Safety (Management) Regulations, GS(M)R, while ensuring that consumers' bills are based more closely upon the energy that is actually delivered.

The Project objectives are to:

- Facilitate the entry of all GS(M)R compliant gases including low-carbon gases
- Propose a fairer billing methodology that reflects the actual energy content

- Reduce the current levels of cross-subsidy between consumers
- Design and implement field trials to study the zones of influence of different gases using measurements and network modelling
- Lower barriers of entry for new gas suppliers/less constraints
- Minimise the propanation requirements for low CV gases

The Problem(s) which needs to be resolved

The GB natural gas industry has evolved rapidly over the last decade. The GS(M)R are designed to protect the gas consumer, and the gas transporter and their assets, from harm. New and different sources of GS(M)R compliant gas are currently constrained from entering the gas supply network because of the commercial and operational arrangements of the Flow Weighted Average Calorific Value (FWACV) billing methodology currently operated by the industry. NGGDL is concerned that these commercial/operational arrangements, rather than safety, preclude the injection of low-carbon gas, examples of which are shown in Figure 2.1.

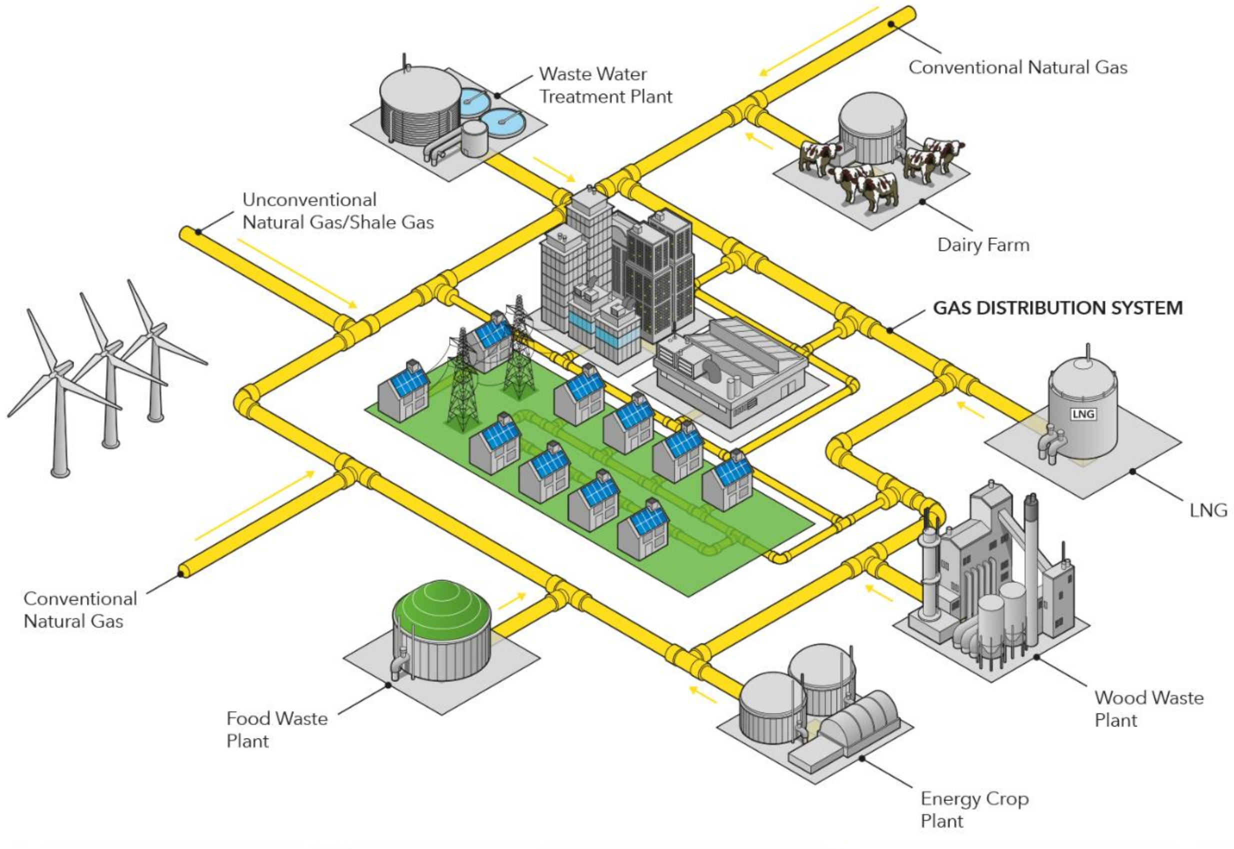


Figure 2.1: A New Billing Methodology is Required for the Sustainable De-Carbonised Gas Networks of the Future

With the growth in unconventional gas supplies, both in terms of volumes of gas and the number of inputs, the existing FWACV billing methodology is unfit for purpose and will lead to significant variation in consumer bills for the same energy requirement. The growing diversity in gas quality injected into the networks of the future will increase the range of calorific values (CV) that a consumer may receive. The existing FWACV billing methodology uses the Local Distribution Zone (LDZ) as the basis for the charging area; consumers that receive gas with a CV lower than the FWACV are being overcharged while those receiving gas with a CV higher than the FWACV are being undercharged: thus cross-subsidy between consumers exists. There are only 13 LDZs for the whole of GB and the geographical areas are large – see 0.

Each LDZ now has a number of entry points with gases from different sources and with different energy content. The FWACV is calculated from the flows and the CVs of all the gas entering the LDZ. As a consumer protection measure, the FWACV used for customer billing cannot be more than 1 MJ/m^3 above the lowest CV entering the charging area – this is known as the CV cap: Figure 2.2 illustrates how the FWACV is calculated for an example of three different gas qualities input into a network.

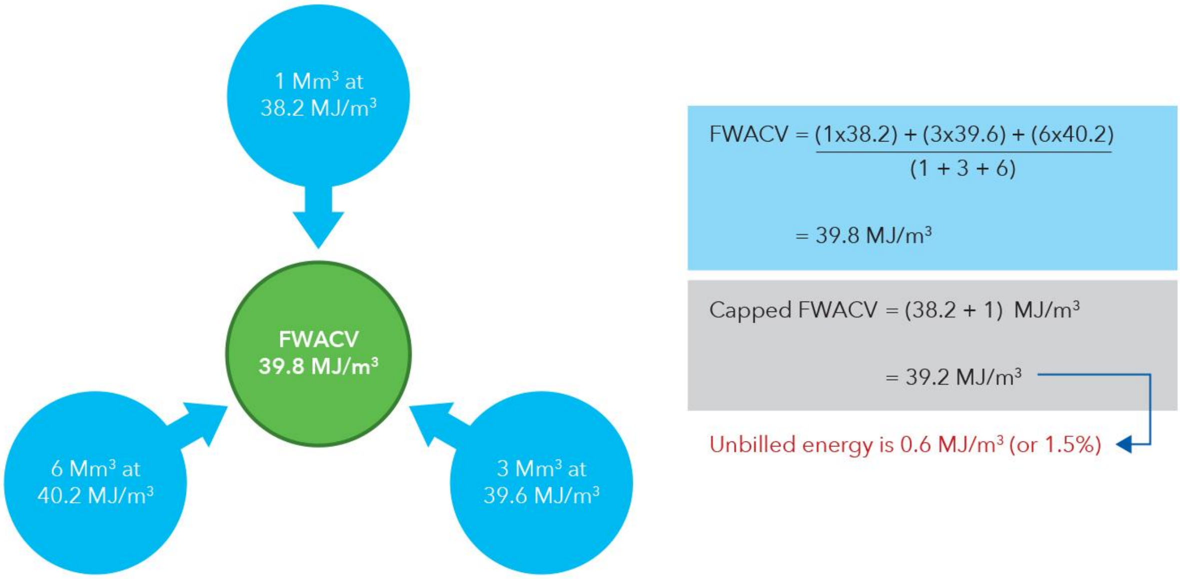


Figure 2.2: Diagram illustrating how the FWACV is calculated and the 1 MJ/m^3 cap imposed to protect the consumer *(the numbers are for illustrative purposes only)*

Gas supplies connected directly to the Gas Distribution Network are known as "embedded" entry connections; gas transporters currently impose a minimum daily average CV on embedded entry connections to prevent the 1 MJ/m^3 CV cap being imposed. Propane is added to enrich the gas to meet the target CV. This is adding carbon to unconventional low-carbon gases which is counter-productive. An insignificant volume of low CV gas can cap an entire LDZ. The CV of the gas delivered to consumers is dependent on the range of the CVs delivered to the LDZ and the consumers' location relative to the supply inputs. Consumers close to a high CV entry point are likely to receive high CV gas and meter a lower volume for a fixed energy requirement leading to lower bills and vice versa. However, consumers are not billed on the CV delivered to their property but rather on the FWACV of the LDZ. The variation in consumers' bills could be £20 per year for the same energy content, however, if the CV cap is invoked, the variation in bills could be £42 per year. Consumers receiving the low CV gas always over pay and all other consumers underpay - an inherent customer cross-subsidy.

Method

The method proposed for the NIC project is to explore three scenarios for reforming the billing methodology is shown in Figure 2.3 and schematically inAppendix 2.

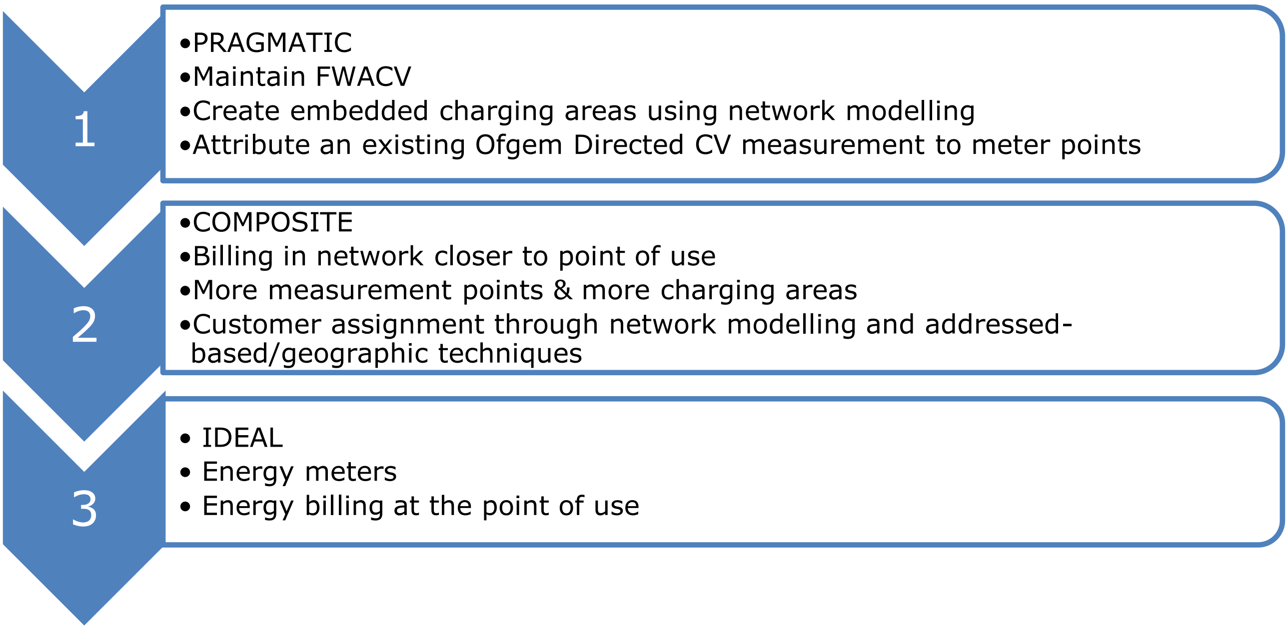


Figure 2.3: Three scenarios to be considered

Scenario 1 is a pragmatic solution that largely retains the FWACV billing regime. There would be embedded charging areas around injection points of gas with a significantly different CV; those customers affected by the dissimilar gas quality would be allocated to a separate charging area and be billed based on the local CV. All consumer bills would be based on existing Ofgem Directed CV measurement sites at the National Transmission System (NTS) offtakes (for the FWACV) area or the Directed CV measurement point of the embedded connection. A possible option for grouping consumers to a charging area is given in Appendix 3, other address / area based options will also be explored.

Scenario 2 is a composite solution which would replace the FWACV methodology. There would be newly installed CV measurement points in the networks alongside existing Ofgem Directed CV measurement points (NTS offtakes and measurement point of embedded connections) providing more charging areas. These charging areas would be smaller and the CV assigned to a consumer will be based on the locally measured CV. A possible option for grouping consumers to a charging area is given in Appendix 3, other address / area based options will also be explored.

Scenario 3 explores an "ideal" solution. It is designed to prove that a measured CV, local to the consumer, can be transmitted to a smart meter, and that the consumer could be billed on current gas energy use, rather than the volume of gas at a FWACV.

<u>Development</u>

The Project seeks to study the pragmatic, composite and ideal scenarios by undertaking field trials, network analysis through modelling and data transfer. In parallel, an industry engagement process will be undertaken which will include stakeholders across the gas supply, transport and delivery chain. Figure 2.4 shows a schematic of the proposed project work flow over three years.

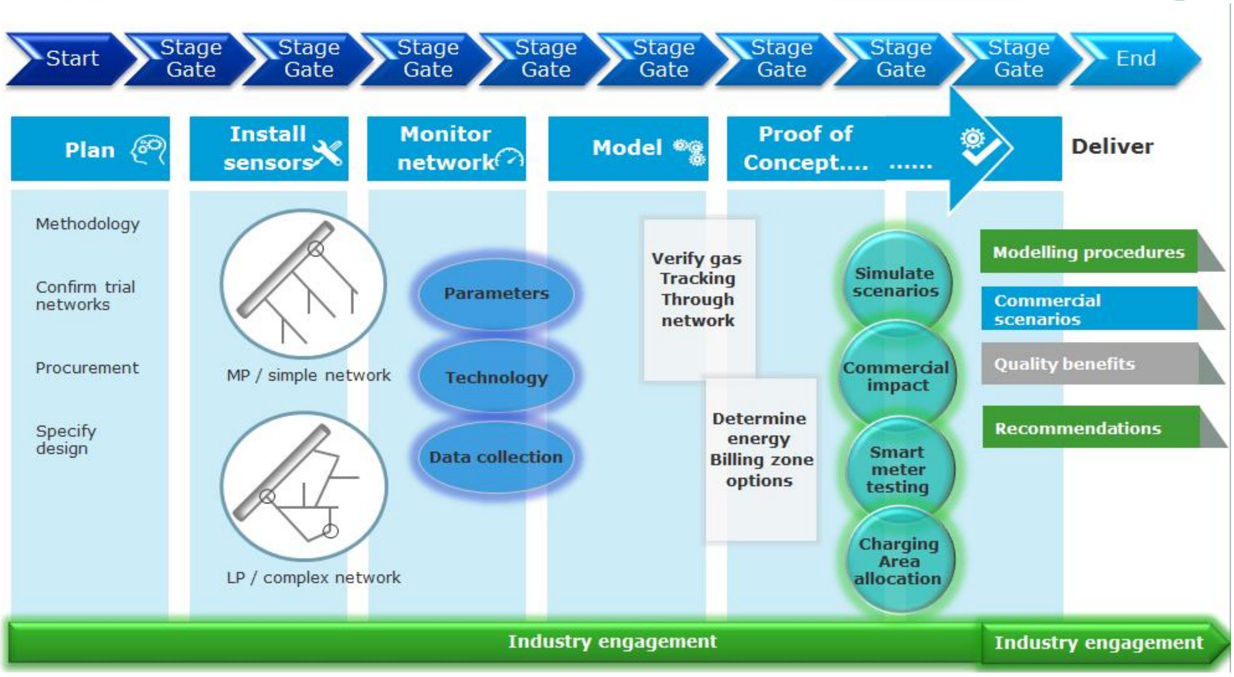


Figure 2.4: Project approach to delivering the Future Billing Methodology solution

All Gas Distribution Networks (GDNs) have computer models of their gas transmission and distribution networks that are validated against measured pressures and flows for operational and capital investment planning. The Project looks at the application of these existing models for the development of a new methodology that would more closely align the billed CV with the CV of the gas supplied. The installation of sensors will provide data to provide additional validation support to demonstrate that network modelling can be used to show the movement of different gases through the network. If validated, implementation of the Pragmatic solution would not require the installation of additional CV measurement equipment whereas implementation of the Composite solution would be likely to require installation of some additional CV measurement equipment within the network.

Solution

The solution that will be enabled is a recommendation for a billing methodology that is more equitable to all consumers and industry stakeholders and promotes the entry of low carbon and unconventional gas supplies that are GS(M)R compliant.

It is proposed that the solution will be based on one of the three scenarios (pragmatic, composite or ideal) described above. A phased GB roll-out could be implemented with an initial 'quick win' pragmatic solution that retains the FWACV methodology but reduces shrinkage, inequalities in consumer billing and propanation.

2.2. Technical description of Project

This Project builds on the work carried out as part of the NIA Project "*Review of the FWACV Billing Regime – Definition of Billing Constraints*" report issued by DNV GL January 2016. The project will involve both the installation of measurements / monitoring points and network modelling to evaluate the zones of influence of a specific source of gas. The three scenarios to be explored are:

1. *Pragmatic* - CV measurement at entry only
Network modelling will be used to identify the zone of influence around embedded entry points of gas with a significantly different CV. Customers that are deemed to be within the zone affected by the different gas quality would be allocated to a separate charging area with bills based on the local, rather than the LDZ, CV. All consumer bills would be based on existing Ofgem Directed CV measurement sites at the NTS offtakes (for the FWACV) area or the Directed CV measurement point of the embedded connection.

2. *Composite* – CV measurement at entry and within network
Network modelling will be used to identify charging areas around CV measurement points, whether they be newly installed CV measurement points in the networks (for CV charging purposes) or existing Ofgem Directed CV measurement points (NTS offtakes and measurement point of embedded connections). There will be more, and smaller, charging areas and the CV assigned to a consumer will be based on the locally measured CV.

3. *Ideal* – CV measurement at the meter
This option will be explored during the Project and it is proposed to prove that a measured CV local to the consumer can be transmitted to a smart meter and that the consumer can therefore be billed on current gas energy use rather than the volume of gas at a fixed predetermined CV.

Note that Ofgem Directed CV measurement points comply with the requirements of The Gas Act 1986 Section 12 and the Gas (Calculation of Thermal Energy) Regulations 1996 and Amendments 1997.

The Project will be delivered in four work packs:

1. Industry engagement
2. Sensors & measurement, network modelling and CV allocation
3. Assigning a CV to smart meters
4. Industry engagement on the options and cost-benefit analysis with a recommended solution

The Project will be split into two phases separated by a stage gate after the first six months. Work Packs 1, 2 and 4 will be divided into parts "a" and "b". Work packs 1a, 2a and 4a combined will deliver:

a) <u>Industry's views on the desire for change to the current billing approach</u>
b) <u>Industry's current views on:</u>
   i. <u>The level of modelling validation required</u>
   ii. <u>The regulatory changes that may be required to support the Project beyond work pack 1</u>
c) <u>Draft cost benefit analysis of the three scenarios to demonstrate that, following industry engagement, there remains a strong case to proceed with the Project</u>

NB: For practical purposes, Work Pack 4a will be merged into Work Pack 1a; this is reflected in the Project plan. Some preparatory site visits and concept design work will also be carried out to enable the Project to be delivered within a three-year time frame.

Work Pack 1a and 1b – Industry Engagement

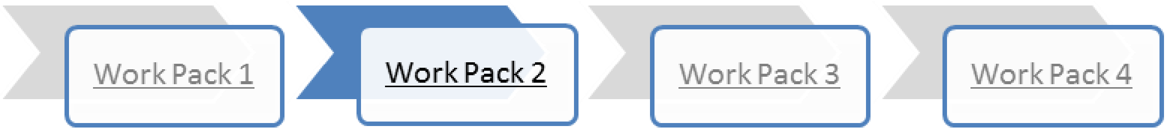
Work Pack 1 comprises an industry engagement exercise hosted by NGGDL to explore the views, issues, constraints and future requirements of a change to the current billing methodology on the industry and stakeholders. Work Pack 1 is divided into two phases, "a" and "b" as described above.

The Department of Business, Energy and Industrial Strategy (formally the Department of Energy and Climate Change or DECC) is integral to ensuring that the UK has secure, clean and affordable energy supplies; the Department is comprised of a number of agencies and public bodies and the relationship between these is shown in Appendix 4. The industry engagement will take the form of a combination of a workshop, meetings, a discussion paper and associated questionnaire to understand the stakeholder impact of:

1. Maintaining and changing the current FWACV system
2. CV measurement at every meter
3. Increased number of charging areas
4. Creation of embedded charging areas with the FWACV system

An outline of the proposed Terms of Reference for the Industry Engagement is shown in Appendix 5 and further detail is contained in Section 5 Knowledge dissemination.

Work Pack 2a and 2b – Sensors & measurement, network modelling and CV allocation



Work Pack 2 aims to deliver a comprehensive review of the impact of changing the way the CV information on a consumer's bill is derived and attributed to the metered volume. Work Pack 2 is divided into two phases, "a" and "b" as described above.

A range of methodologies for CV attribution and allocation to Meter Point Reference Numbers (MPRNs) is to be studied. These will be underpinned by field trials involving the selection, procurement and installation of measurement equipment at a number of sites. Network modelling tools and techniques will use the field trial measurements to investigate methods for better defining charging areas. Two field trials are planned around embedded non-conventional gas injection points within the NGGDL network:

- The Low Pressure (LP) network centred on the Medium Pressure (MP) feed from Chittering biomethane input.
- The geographically more extensive MP network centred on Hibaldstow biomethane input. This trial will also look at the impact of upstream Intermediate

Pressure (IP) embedded biomethane entry and the dispersion into the downstream LP network.

These trial networks were selected as representative of the development of biomethane connections in terms of operation, pressure tier connection and contracted flow rates. They feed into networks that have other gas entry points so the mixing of gases from different sources can be investigated and modelled. The networks that they feed are reflective of general demands and customer behaviour. These trial sites are typical of embedded entry points and it is anticipated that the learning can be applied elsewhere.

Network modelling will initially be used to identify the location of the measurement points at variable demand levels as the absorption of the unconventional gas varies with the demand. The absorption generally increases with reduction in demands, assuming a constant flow rate from the unconventional gas source. This is described in more detail in 0.

The field trial measurements are required to validate the network modelling technique as a robust and equitable methodology for the creation of charging areas and the allocation of CV. This methodology will be used for both scenario 1 *Pragmatic* CV and scenario 2 *Composite.*

<u>Work Pack 3 – Assigning a CV to Smart Meters</u>

Work Pack 3 is a technology trial to deploy a hosted environment to prove the assignment of network CVs to individual smart meters. This should lead to a better understanding of the capabilities and processes for managing the associated smart meter device and communications technologies. The possibility of sending a live CV from the field via the Data Communication Company to suppliers and individual smart meters will be investigated; this will enable consumers to understand their usage of gas energy, rather than the gas volume, to further improve the estimation of consumer bills. The process would be simulated and tested at the newly-opened smart energy and cyber security testing facility at DNV GL's Technical Assurance Laboratory (DTAL) located in Peterborough.

Laboratory based trials with Smart Metering Equipment Technical Specification, Second Version (SMETS2) compliant gas meters are planned to be representative of the 21+ million gas meters that will be deployed in the next few years. This will demonstrate how thermal energy data and/or other conversion factors from real sensors in the field will be logged over a communication network, validated/processed and transferred to real smart gas meters over the Data Communications Company (DCC) network. It is planned to demonstrate the concept using CV measurements deployed in Work Pack 2 which are representative of the type of real sensors and communications equipment that is likely to be deployed in live operations. The DCC communications infrastructures will be simulated.

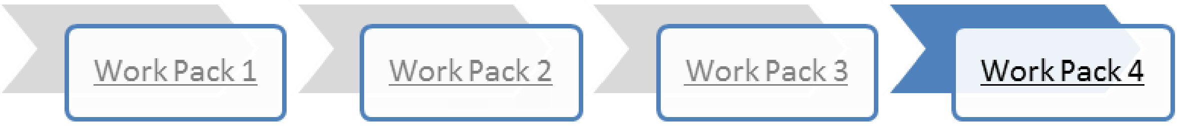
The benefits of this approach include:

- Flexibility to model different elements of the smart metering communications architecture without impacting consumers and DCC in the trial

- Demonstrating feasibility of approach whilst minimising risk

The designation of CV charging areas and the allocation of a CV measurement to an individual MPRN could optimise industry investment and benefits of smart metering. This trial aims to contribute to the understanding of scenario 3. Further information on the DNV GL facility is provided in Appendix 9.

<u>Work Pack 4 – Industry engagement on the options, cost-benefit analysis with a recommended solution</u>



Work Pack 4 is intended to build on the industry engagement, network modelling and data analysis work and smart meter investigations carried out in the previous three work packs. The high-level cost-benefit analysis aims to cover the GB gas industry including the implications for shippers and the impact on end user bills etc. Comments and review will be sought from all stakeholders on matters including the impact on current regulations, billing process and commercial arrangements. A cost-benefit analysis will be carried out to inform Project recommendations. An initial version of the cost-benefit analysis will be undertaken the accelerated industry engagement that forms part of Work Pack 1a.

Further industry engagement is proposed to examine the effectiveness and achievability of the scenarios. Any change in billing methodologies could impact Regulations such as Gas (Calculation of Thermal Energy) Regulations, billing organisations such as Xoserve, process systems such as Nexus and shipper systems, new connections, Renewable Heat Incentive (RHI) and consumer billing. A change to billing methodology, potentially phased, would be recommended that delivers a solution that more closely reflects the energy delivered at a consumer meter. It would also address some of the inconsistencies and cross-subsidies that are intrinsic to the averaging in the FWACV approach.

The final Project deliverable is a report to the industry detailing the recommended solution along with a high-level implementation plan. Implementation would be covered in subsequent industry projects.

2.3. Description of design of trials

<u>Measurement of Biomethane in the Gas Distribution Network</u>

Field trials are planned to develop a detailed understanding of the zone of influence exerted by the embedded entry point. There are three options; use of either propanated or un-propanated gas supplies or a combination of the two. The advantages and disadvantages of each option are shown in Appendix 10. The challenges associated with defining a new charging area are detailed in 0. Due to the potential legal issues associated with stopping propane injection for embedded low CV inputs, these trials will focus on tracking the biomethane using a unique marker. The most likely candidate is oxygen concentration – see Appendix 7. A schematic of the proposed field trial is shown in Figure 2.5.

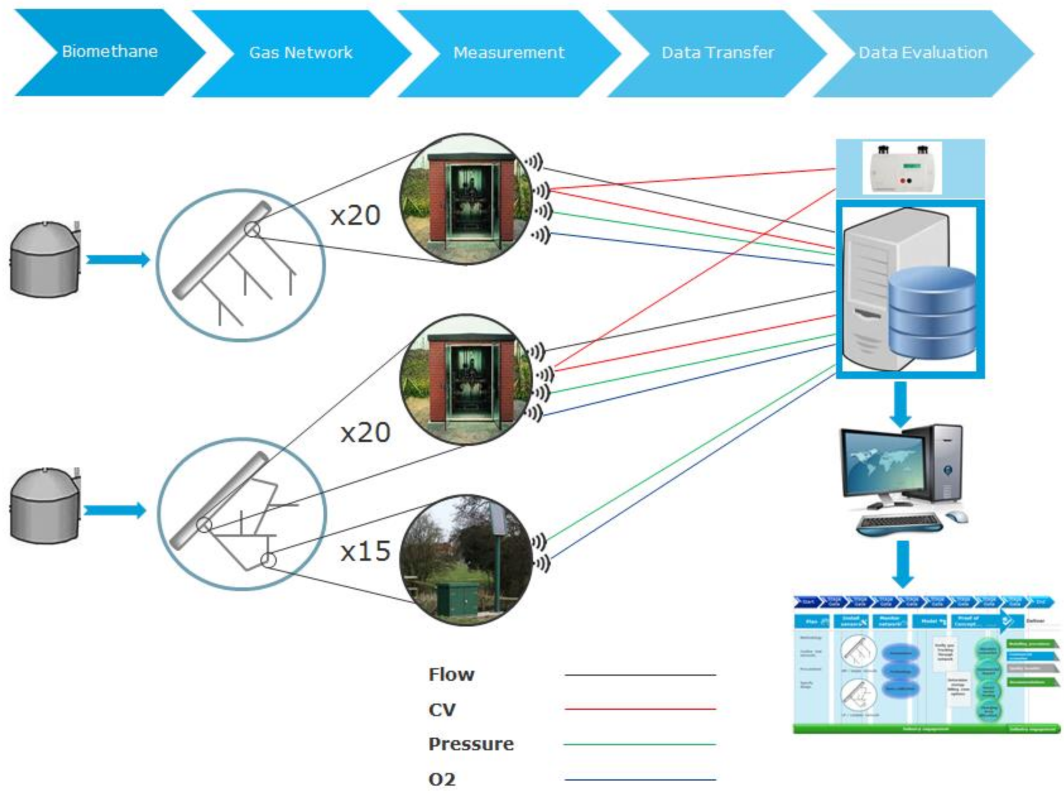


Figure 2.5: Schematic diagram of the field trials to show measurements and data transfer

It is planned to measure an indicative gas flow using an innovative low-cost technique developed by Advantica (now DNV GL) in 2002; the method relates gas flow to the open/closed percentage of the governor regulator. CV will be measured at about four selected sites to demonstrate transmission to smart meters. The measurements will be transmitted at a suitable frequency to DNV GL using mobile communications technology such as GPRS.

A summary of the proposed measurements and their location is shown in Table 2.1.

Site Type	Biomethane marker (oxygen)	Gas pressure	Gas flow indication	CV (selected sites only)
Governor Stations (Hibaldstow & Chittering)	✓	✓	✓	✓
LP Network (Chittering)	✓	✓	*X*	*X*

Table 2.1: Summary of measurements and locations

<u>Attributing CV to Smart Meters</u>

DNV GL has developed a comprehensive suite of tools to simulate and assure components of the smart metering infrastructure. The tools are compliant with the latest SMETS2 technical standards and are being used to test current smart electricity and gas meters, in-home displays and other devices. The tools have been deployed in the DNV GL Smart Energy Labs in Peterborough and London, and by manufacturers and energy suppliers for in-house testing. In support of testing, DNV GL has developed a simulation of the DCC environment and emulators of the communication hub, in-home displays and other support devices.

It is proposed to use the simulation system to host a lab-hosted environment to control stakeholder interaction with physical SMETS2 compliant smart gas meters and CV sensors.

The lab-hosted simulation architecture may be extended to include a limited field deployment of smart meters and CV sensors. The aim of the Field Trial is to prove that real-world data can be generated and acquired from a sensor network and the data can be deployed and used effectively by real smart gas meters.

2.4. Changes since Initial Screening Process (ISP)

Since the Initial Screening Process the Work Packs have been realigned following discussions between project partners. The Work Packs have been changed to deliver a more coherent Project output. Industry Engagement has been brought to the front of the Project as Work Pack 1 to ensure that the industry has the opportunity to comment and reflect on the effectiveness and achievability of the scenarios being investigated. In addition, Industry Engagement will also continue into Work Pack 4 as this is key to achieving acceptance and support for the recommendations. A stage gate has been inserted after the first six months; this will allow Ofgem to consider the Industry's views and the requirement for a change to the billing system. The full details of the Work Packs can be found in Section 2.2.

It is now the intention to track the concentration of oxygen associated with the biomethane rather than the CV as stated in the ISP. In the ISP it was envisaged that the propane could be switched off in order to track the distinctive CV of biomethane. However, it was found that it would not be possible to gain exemption from the Regulations as detailed in 0. The zone of influence of the biomethane will now be traced and modelled by means of oxygen concentration. From this modelling the CV can be inferred.

Two field trials will be carried out instead of three. Hibaldstow is an example of mixing of different gases across the IP, MP and LP tiers whereas Chittering enables modelling of dispersion across a complex LP network.

Project Partners – The Network Licensee will be NGGDL with DNV GL as the Project partner.

Section 3: Project business case

3.1 Summary

The current averaging approach that is applied for attributing the energy content of the gas being transported to consumers within 13 LDZ charging areas is termed the FWACV billing system. The FWACV methodology is fit for purpose in a gas distribution system that is fed by multiple large volume inputs from the NTS, where gas is of very similar energy content (expressed as Calorific Value, or CV). The FWACV methodology features a CV capping mechanism that was introduced to protect customers from over-billing, and which limits the billed CV value to 1 MJ/m^3 above that of the gas having the lowest source CV. Under the FWACV regime, the NTS carefully manages flows of gas in its system to ensure that any disparity in CV for gas entering a given LDZ is minimised. However, increasingly, unconventional low-carbon gases are entering the network downstream and these are outside the control of the NTS – these gas inputs are termed embedded connections. These low CV and green gases are enriched to match the CV of NTS gas by adding propane which negates the carbon benefits.

This Project would:

- Accelerate the development of a low carbon energy sector and deliver environmental benefits by facilitating the injection of unconventional gases without propane enrichment
- Have the potential to deliver net financial benefits by the removal or reduction of:
    - Propane enrichment
    - CV shrinkage in the NTS
    - Unfairness in consumer billing
- Deliver value for money to gas customers by:
    - Developing cost benefits for three scenarios for potential roll-out in stages to GB
    - Developing the potential for getting closer to energy billing using smart meters
    - Enabling a generic solution for determining charging areas
    - Carrying out the Project without impacting on consumers and stakeholders by imposing the 1 MJ/m^3 CV cap
    - Ensuring the continued use of the gas grid as an economic and efficient alternative to electrification
- Be innovative (not business as usual) by:
    - Using novel measurements in the gas network around two representative biomethane embedded connections
    - Developing new methods for determining charging areas
- Involve DNV GL as an independent partner to deliver the Project
- Be relevant in terms of the changes to GB gas supplies and other industry initiatives such as hydrogen, shale, biomethane, bio-SNG and changes to GS(M)R
- Be timely for planning for the RIIO GD2 review in 2021

3.2 Great Britain Energy System Benefits

The GB gas distribution system is a world class asset for transporting gas from the point of entry to the point of use. The Project is the key enabler for a sustainable cost-efficient, low-carbon means of fuelling domestic and commercial space and water heating. It promotes the use of the gas grid, returning benefits on existing investment by gas consumers, to provide an economic alternative to the costly re-engineering of the electricity generation and supply chain. This also protects consumers from the significant cost outlay on changing appliances and heating systems.

The Project would bring inherent customer and stakeholder benefits in terms of a more robust and fair energy attribution to customer bills. It is pivotal to facilitating alternative gas sources and the use of more cost effective energy sources, including indigenous shale gas and hydrogen. The Project is relevant and timely for GDNs planning for RIIO GD2 price control review in 2021.

The Project is also an enabler for a number of other on-going projects, the benefits of which (see Section 4) will not be fully realised if the limitations inherent to the current billing system are not addressed.

The introduction of alternative sources of gas, such as biomethane – which is of a materially lower CV than gas from the NTS – would create a distortion in the allocation of billed energy to consumers, unless the energy content of the biomethane source is artificially enhanced. This is currently achieved by the injection of propane at source by the biomethane producer. The addition of propane – a relatively carbon-rich gas – to the biomethane stream negates the environmental benefit that would otherwise be realised. The Future Billing Methodology Project could unlock significant financial and carbon savings from the avoidance of adding propane to low CV gases.

The need for artificial energy standardisation, and the additional cost it carries, creates a barrier to entry for renewable and alternative sources of gas which, typically, have lower energy content than gas from the UK Continental Shelf (UKCS) or LNG. This is clearly unsustainable in a future gas market where multiple and diverse sources of gas, including lower-carbon sources such as biomethane/bio-synthetic gas and potentially hydrogen blend, could be used to fuel domestic and commercial space and water heating.

3.3 Network Licensee Benefits

NGGDL Strategic Direction

This Project is fully aligned with NGGDL's strategic direction of removing barriers for the development of low-carbon sources of gas as outlined in the National Grid Gas *Future Energy Scenarios*. An NIA project examining the FWACV billing regime has already been carried out and this has informed the scope and potential benefits of this Project proposal.

The gas industry has a very large customer base and 83% of GB households are connected to the gas grid. The UK has signed up to EU *Renewable Energy Directive* which agrees to legally binding targets of 15% of energy from renewable sources by 2020. Modelling by the Department of Energy and Climate Change (now the Department of Business, Energy and Industrial Strategy) has shown that this could mean that renewable energy source should be used to generate 12% of energy for heating. Wales and West Utilities carried out the *Bridgend Future Networks* Project which investigated the implementation of renewable technologies. An extract from Phase 2 *Willingness to Pay* is given below:

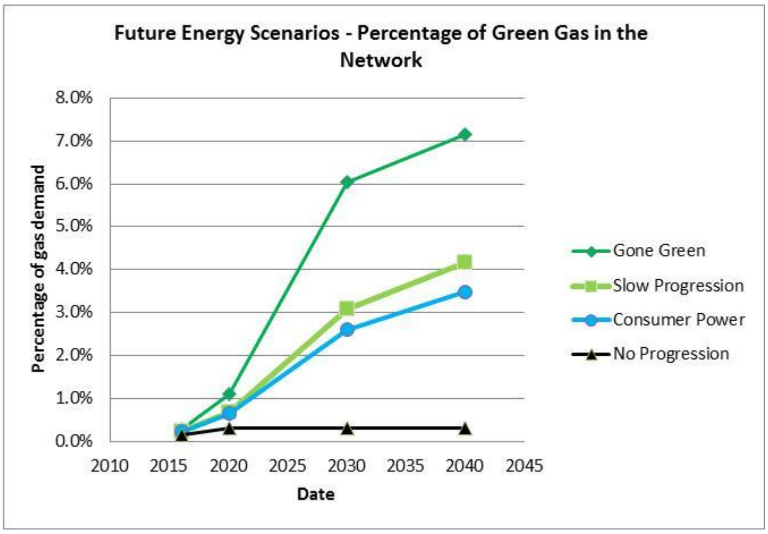
A key finding is that the majority of domestic consumers (87%) will not change their existing heating provision unless significant financial benefits will be accrued, and only then if they have funding available, i.e. readily available cash to replace a heating system or low cost loans, and only if the system is coming close to the end of its cost effective life cycle and/or actually fails. Without these potential failure signs, then consumers would simply opt to do nothing. If their current system was operating well and providing heat for their homes they would not change their heating systems and spend money unnecessarily.

If consumers are unable or unwilling to convert to renewable energy for heating then the GDNs can facilitate with renewable gas delivered to consumer's homes and businesses.

Individual Network Benefits

The major benefit from the Project is the facilitation of low carbon and carbon-neutral gases into the NGGDL network and the removal of the requirement to add propane. This would also facilitate a reduction in NTS exit capacity requirement by offsetting capacity by unconventional gas supplies. The requirement to accommodate low-carbon gas will continue to grow with time but, without billing changes, these gases will require propane addition to increase the CV.

The National Grid *Future Energy Scenarios* document explores four energy scenarios:



- *Gone Green* – the 2050 carbon reduction target is achieved
- *Slow Progression* – economic conditions restrict the transition to low carbon
- *Consumer power* – high prosperity/consumer power dominates over carbon reduction
- *No Progression* – business as usual with short term focus on traditional fuels

Figure 3.1: Percentage of gas supply predicted to be green gas by the Future Energy Scenarios

The *Gone Green* scenario predicts that by 2040, green gas will comprise 7.1% of gas demand. Even for the *Slow Progression* and *Consumer Power* scenarios, green gas is predicted to comprise 4.2 and 3.5% of demand by 2040 as illustrated in the plot above. Additionally, if GB shale gas is low CV, although this may not be low-carbon gas, it would still require propane addition – a further reversal in the decarbonisation of the gas grid.

New Opportunities

The Project will enable the emergence of low-carbon gases and enable the potential for hydrogen injection into the grid as proposed by projects such as NGGDL's *HyDeploy* NIC proposal and the NGN's *H21* initiative in Leeds. The SGN *Opening Up the Gas Market* NIC project in Oban aims to increase the GS(M)R Wobbe Index limit which will also increase the CV range. The SGN *Real-Time Networks* project seeks to create a flexible network of the future that can accommodate both conventional and unconventional gas supplies.

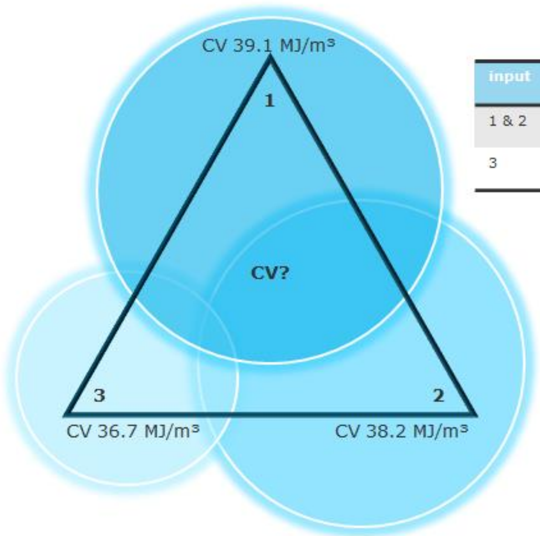
Underpinning the life of the Network

By proposing changes to the billing methodology, the Project is enabling the gas network of the future to transport renewable energy to consumers and bill in an equitable way that reflects the energy (rather than the volume) of the gas that has been used.

3.4 Customer Benefits

Financial Benefits – Fairness of Customer Billing

The current FWACV methodology leads to inequity of billing between consumers causing some consumers to be undercharged at the expense of consumers who are being overcharged. The cross subsidy between consumers is a direct result of the averaging process. To understand and quantify what this might mean to a customer in different CV zones a simplified network diagram has been used as shown in Figure 3.2.



input	Description
1 & 2	Indicative of NTS Offtake
3	Indicative of biomethane offtake

Figure 3.2: Three gases with different CVs supplied to an LDZ *(the diameter of the circles indicate the volume in the network and the overlap the extent to which consumers will receive each type of gas)*

A detailed analysis is given in Appendix 11. It is based on a single domestic consumer in each of the zones with the same energy use of 13,500 kWh in each of the 3 billing examples, A, B & C. It is also assumed that customers close to an input will predominantly receive that gas. Note that the metered volume of gas will differ because of the different gas CV and hence energy content. The figures for an individual consumer have been extrapolated to one million customers in Table 3.1. Consumers in zones 1 and 2 benefit from CV capping but consumers in zone 3 overpay. Under FWACV, consumers receiving the richest gas in zone 1 benefit at the expense of consumers in zones 2 and 3.

Zone	1	2	3	Total
Number of consumers	497,500	497,500	5,000	
FWACV to low capped bill	-£8,109,250	-£8,303,275	£34,050	-£16,378,475
FWACV to "true" bill	£3,840,700	-£3,930,250	-£57,400	-£146,950

Table 3.1: Total billing differences based on 1,000,000 domestic consumers

For reference, the approximate total MPRN count for the NGGDL LDZs is EA 1.8 million, EM 2.2 million, NT 2.2 million, NW 2.7 million and WM 1.9 million.

There is a significant difference in consumers' bills. These examples were based on the assumption that a consumer in each zone needs the same energy input so, in an ideal situation, should receive the same bill. Although the FWACV is a reasonable way of dealing with small variations in CV this is clearly not the case when a significant range of CVs are introduced into a gas supply system. In the example above, a move from FWACV to a capped CV, the 'under payment' of £16.5 million, calculated at an LDZ level, would need to be accounted for in the overall consumer billing process – this is potentially CV Shrinkage.

Financial Benefits – Removal of Propanation

Calculations on the savings in the purchase of propane have been based on the conservative price of 2.27 p/kWh which was the value used in the precursor NIA project, compared with an assumed average cost of 1.3 p/kWh for natural gas. The percentage of low CV gas in the network was taken from the National Grid *Future Energy Scenarios*. All the scenarios have an associated propane cost – for shale gas, it has been assumed that the CV will be low and all inputs will require propane addition. The incremental cost of propane per year is summarised in Table 3.2 for each of the National Grid *Future Energy Scenarios.*

Scenario	Gas Source	2016	2020	2030	2040
		£M/year (constant prices)			
Gone Green	Shale	0.0	0.0	0.0	0.0
	Biomethane & Bio SNG	1.0	3.7	20.5	24.3
	Total	**1.0**	**3.7**	**20.5**	**24.3**
Slow Progression	Shale	0.0	0.0	0.0	0.0
	Biomethane & Bio SNG	0.8	2.3	10.5	14.1
	Total	**0.8**	**2.3**	**10.5**	**14.1**
No Progression	Shale	0.0	0.0	69.4	74.2
	Biomethane & Bio SNG	0.6	1.0	1.1	1.1
	Total	**0.6**	**1.0**	**70.5**	**75.3**
Consumer Power	Shale	0.0	0.0	150.4	171.4
	Biomethane & Bio SNG	0.8	2.2	8.9	11.9
	Total	**0.8**	**2.2**	**159.3**	**183.3**

Table 3.2: Incremental cost of propane for each of the Future Energy Scenarios

Non-Financial Benefits – Local Attribution of Energy

The adoption of a future billing methodology under which gas energy is attributed at a more specific level could allow multiple sources of gas to be used without the need for artificial energy standardisation. This would both realise the value of low-carbon gases and generate financial savings for consumers due to the removal of the need to add propane. As the representation of low-carbon gases in the LDZ increases over time – as projected in some of the National Grid *Future Energy Scenarios* – the savings in terms of propane alone could be very significant as shown in Section 4.

The application of the Future Billing Methodology would also carry inherent benefits by providing a more robust allocation of gas energy costs to consumers, as the more local attribution of gas energy would ensure that customers are billed more closely in line with the actual CV of the gas being delivered at the consumer's meter.

Non-financial Benefits - Increase Security of Supply

Facilitating diverse sources of gas into the network will promote security of supply and reduce the dependency on traditional fossil fuels (see Appendix 13 for the range of gases that could be supplied to the GB gas network). The Project aims to facilitate the injection of all GS(M)R gases both now and in the future:

- Unballasted LNG (subject to change in upper Wobbe Index in GS(M)R – ongoing)
- Hydrogen
- Biomethane
- Shale
- Bio SNG
- Traditional North Sea Gas
- European gas supplies

As part of the flow measurement at governors, the percentage load on governor capacity will be an output – this will allow the levels of demand to be assessed and a relationship to be investigated between the network demand level and the size of the "low CV" zone. This is likely to provide additional information on system behaviour that may enable GDNs to optimise network operation, pressures and hence security of supply in the test area. The effectiveness of this measurement technique will be assessed for potential wider use.

3.5 Environmental Benefits

Under the output from the Future Billing Methodology, the existing gas grid – which is already paid for by gas consumers – could provide an economical means to supply low-carbon fuel for domestic and commercial space and water heating into the future. Particular attention is now being paid to how hydrogen, a low CV gas, could fulfil this role. The wholesale use of low-carbon gases would help the UK to achieve its carbon reduction target and mitigate the large-scale infrastructure upgrade costs for electricity that would otherwise be required. It would also avoid the need for significant capital outlay for consumers on alternative heating appliances.

Reduction of Carbon Dioxide Emissions

Methane, typically comprising about 90% of natural gas, contains one carbon atom and produces one molecule of carbon dioxide when it is burnt. Propane contains three carbon atoms and produces three molecules of CO_2 when burnt. The CV of propane, however, is about 15% less than three times the CV of methane while the quantity of CO_2 produced is 20% greater per unit of energy produced.

In terms of CO_2 production, propane is a less environmentally friendly fuel than methane. This is a further reason to review the use of propane for enriching low CV gases. The details of these calculations are shown in Appendix 12.

3.6 Relevance and Timing of this Project

If accepted, the output of this Project – a report which sets out the Project findings and high-level investment options for implementation of a future billing methodology – would be available to the industry ahead of the commencement of RIIO GD2.

Section 4: Benefits, timeliness, and partners

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

The Project aims to accelerate the development of a low-carbon energy sector by changing the billing methodology so that:

- Propane addition to biomethane and other low CV unconventional gases (including potentially shale gas) is no longer necessary
- The connection of low-carbon and carbon neutral gases is facilitated thus reducing carbon dioxide emissions
- Gas processing for GS(M)R compliant gases is reduced or removed
- The connection of hydrogen to the gas grid is enabled
- Other NIC projects can better deliver benefits after roll-out to GB
- Creating a fairer and more equitable commercial arrangement so that all stakeholders and customers may benefit from a low-carbon gas grid

The Project is an essential enabler for meeting the requirements of the Carbon 2016 budget; this sets a cap on the maximum level of the net UK carbon account (defined in section 27 of the Climate Change Act 2008) for each five-year budgetary period.

Figure 4.1 summarises the relationship between the types of gases entering the GB network, on-going and bidding NIC projects and this Project proposal.

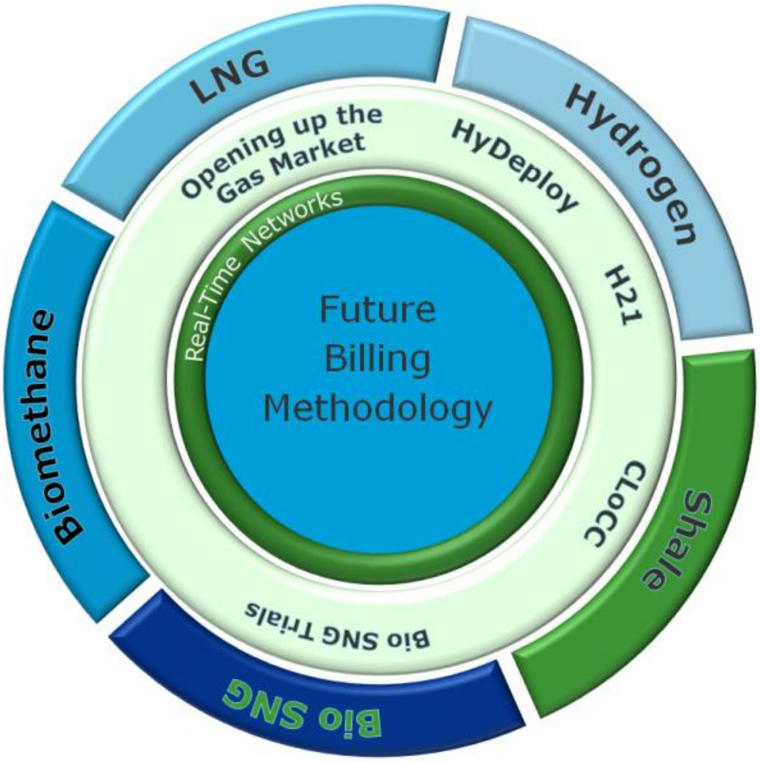


Figure 4.1: The Future Billing Methodology Project in relation to the future GB gas network

Two case studies on the benefits of the removal of propane addition and the injection of hydrogen into the gas grid and how they accelerate the low carbon sector and deliver environmental benefits are given below.

Case Study 1 - Removal of Propane Addition

The Project will enable the removal of propane addition which will accelerate the low carbon energy sector and deliver environmental benefits. By implementing the outputs from the Project:

- New connections will not require propane addition
- Existing connections can cease propane addition and realise the low-carbon benefit that is currently negated
- Carbon dioxide emissions are reduced (see Appendix 12)

The Project will investigate how small unconventional connections to the gas network operate and how they impact on consumer bills. Biomethane plants, for example, are designed to operate at a constant flow into the network and the geographical area supplied varies with the network demand. At high demand the gas can be absorbed in a smaller area than when the demand is lower and as a consequence the number of consumers supplied from the low CV source will be greater in the summer than in the winter. Unconventional gas suppliers cannot sustain the addition of propane as the flow rates increase. The cost of propanation equals the cost of shrinkage (caused by the CV cap) when 19% of the gas entering the network is low CV - with shale gas this volume of gas is a possibility (see Figure 4.2). About 0.27% of the gas currently injected into the GB gas network is low CV gas and the cost of propanation is over £2million per year – this borne by the consumer through the Renewable Heat Incentive (RHI). A conservative cost for propane has been assumed at 2.27 p/kWh.

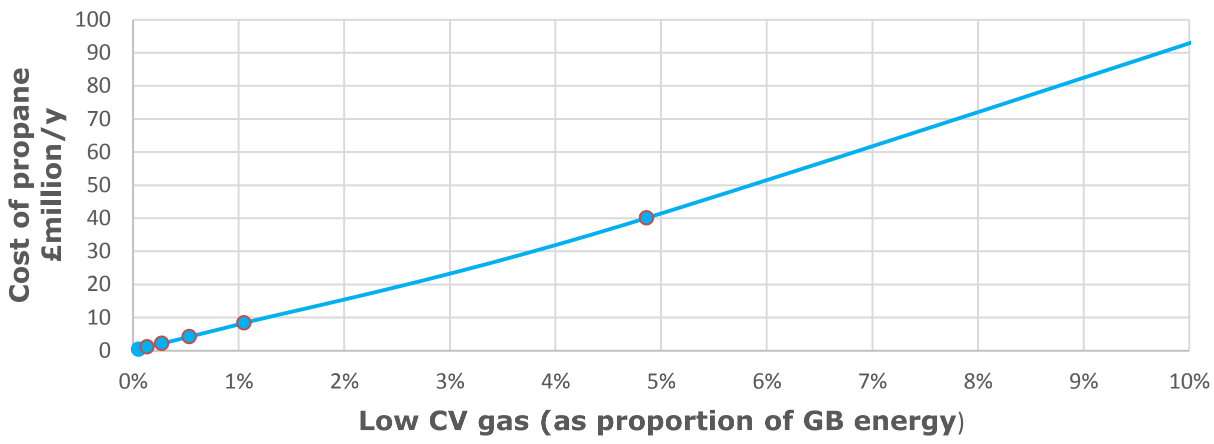


Figure 4.2: Relationship between the cost of propane and the percentage of biomethane in the GB network.

The Project cost is £5.4 million. The current annual cost of propane has been estimated at £2 million and would increase to £40 million if low CV unconventional gas injection increases to 5% of gas in the network (assuming the price of propane remains the same) and £60 million if injection increases to 7% (see Figure 3.1) which used data from the National Grid *Future Energy Scenarios*. The cessation of propane injection without reforming the FWACV billing regime is predicted to impose the 1 MJ/m^3 CV cap every day which will significantly increase CV shrinkage and gas transportation charges.

If the RHI were withdrawn, either producers would stop putting gas into the network or they could inject low CV un-propanated gas and the CV cap would be invoked. This would affect all consumers because the shrinkage volume would increase. CV Shrinkage and other costs are recovered through the commodity charging mechanism. However, the deliberate invoking of the CV cap would conflict with consumers' interests under the Regulations (see 0).

Case Study 2 - Hydrogen Injection into the Gas Grid

Hydrogen is a molecule that leaves no carbon footprint and the combustion of H_2 with oxygen results only in water and heat. Power-to-gas technology generates H_2 from "surplus" electricity and the proposition is that the GB gas transportation network is used as an energy storage system. This is an alternative and novel use of the investment in the extensive gas network to deliver energy to consumers when and where they require it.

The current GS(M)R limit for H_2 in the natural gas grid is 0.1 mol% and this limit is often seen as a key barrier for the introduction of H_2. The HyDeploy NIC submission, however, is seeking to demonstrate that this limit can be safely extended. This will also facilitate the injection of bio-SNG into the gas grid by reducing operational costs for conversion of H_2 to methane. A further barrier to H_2 addition is the FWACV billing regime. On a volumetric basis, H_2 has a low CV and the impact of adding H_2 to a typical natural gas with a CV of 39.3 MJ/m^3 is illustrated in Figure 4.3: for each 1 mol% of H_2 added, the CV of the gas blend decreases by 0.27 MJ/m^3.

For mixtures of natural gas containing 3 to 3.5 mol% of H_2, the 1 MJ/m^3 CV cap will be invoked under the FWACV billing regime. Note also, that the quantity of H_2 that can be added will vary depending on the prevailing natural gas quality so that the commercial limitations of the FWACV billing regime will require an additional safety margin (much as they apply to the propanation of biomethane).

The H21 Leeds Citygate project aims to redesign the gas network for Leeds to establish a high pressure (17 bar) outer city ring main transporting methane to strategically placed steam methane reforming plants; these will create pure hydrogen for distribution into the below 7 bar network. The supply of H_2 will also be supplemented by power-to-gas technology.

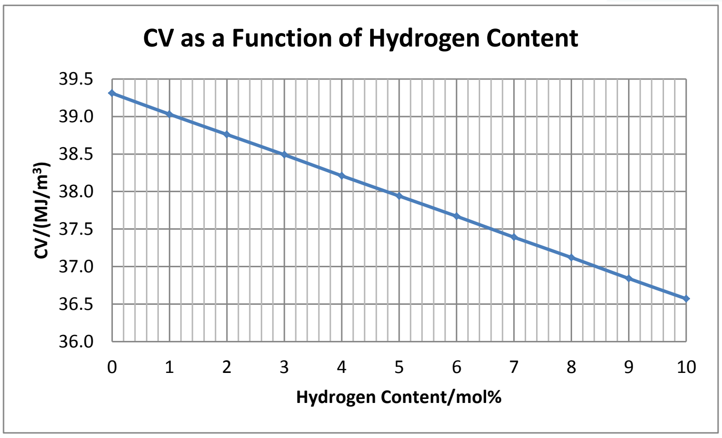


Figure 4.3: Plot to show the relationship between CV and hydrogen content in natural gas

(b) Provides value for money to gas Customers

The Project costs have been kept to the minimum to achieve the outputs:

- Existing gas networks are being used for the field trial with minimal impact on network day-to-day operations
- Stakeholder buy-in for the recommendations will form part of the project
- Innovative techniques are being implemented by tracking oxygen in biomethane and thus avoiding the CV cap that would result from turning off propane injection
- A competitive tendering process will be undertaken to appoint the sub-contractor who will install, maintain and decommission the equipment on the NGGDL network.

A summary of the costs per work pack are given in Table 4.1. The work packs were defined in section 1:

- Work Pack 1(a and b) - Industry engagement
- Work Pack 2(a and b) - Sensors & measurement, network modelling and CV allocation
- Work Pack 3 - Assigning a CV to smart meters
- Work Pack 4 - Industry engagement on the options and cost-benefit analysis with a recommended solution

The NGGDL costs are associated with project management, hosting the industry engagement, liaison with Xoserve on potential changes to the billing system and support from network engineers for work carried out on NGGDL assets.

The total number of FTE days from DNV GL and NGGDL is estimated to be 3225 at an average day rate of £744 per day.

Work Pack	Total Cost	Labour	Equipment	Contractors	IT	Travel & Expenses	Decommission
1a & b	188,688	185,928	-	-	-	2,760	-
2a & b	4,099,618	1,243,860	144,000	2,477,400	2,301	25,080	206,976

3	167,953	163,948	3,525	-	-	480	-
4	293,845	293,665	-	-	-	180	-
NGGDL	630,698	514,675	14,284	41,239	60,500	-	-
Total	5,380,801	2,402,076	161,809	2,518,639	62,801	28,500	206,976

Table 4.1 Summary of Project costs by work pack and activity

DNV GL and National Grid have both used internally approved pricing processes that have had rigorous commercial review and challenge.

(c) Generates knowledge that can be shared amongst all relevant Network Licensees

The Project will be engaging and sharing knowledge with all the other Gas Network Licensees as part of the industry engagement process in Work Pack 1 and Work Pack 4:

- The output from the industry engagement process
- The methodology for defining charging areas for the Scenario 1 *Pragmatic* and Scenario 2 *Composite* solutions which will be independent of the network modelling software
- Proof of concept for sending a CV to a smart meter as part of Scenario 3 *Ideal* solution
- The use of sensor technologies for tracking biomethane in a gas network

Implementation of a new billing methodology will necessarily involve all the gas networks and other industry stakeholders; sharing of knowledge is built into the Project plan and is key to delivering a successful Project outcome.

During the Project, interim and final reports will be generated. Project closure reports will include engagement with stakeholders and the provision of high-level investment options for a Future Billing Methodology.

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

The perceived benefits to be gained from ongoing and future low-carbon projects cannot be achieved within the constraints of the current billing methodology. These preclude the injection of volumes of gas that are materially higher or lower than the prevailing Flow Weighted Average Calorific Value of the network. Under the current billing methodology, sources of low carbon gas have an adverse effect on the CV shrinkage in the NTS and create cross-subsidies between gas consumers.

This Project could not be carried out as a business-as-usual activity because:

- It seeks fundamental reform to the billing methodology which has potential commercial, regulatory and operational impacts on stakeholders across the whole gas delivery chain.

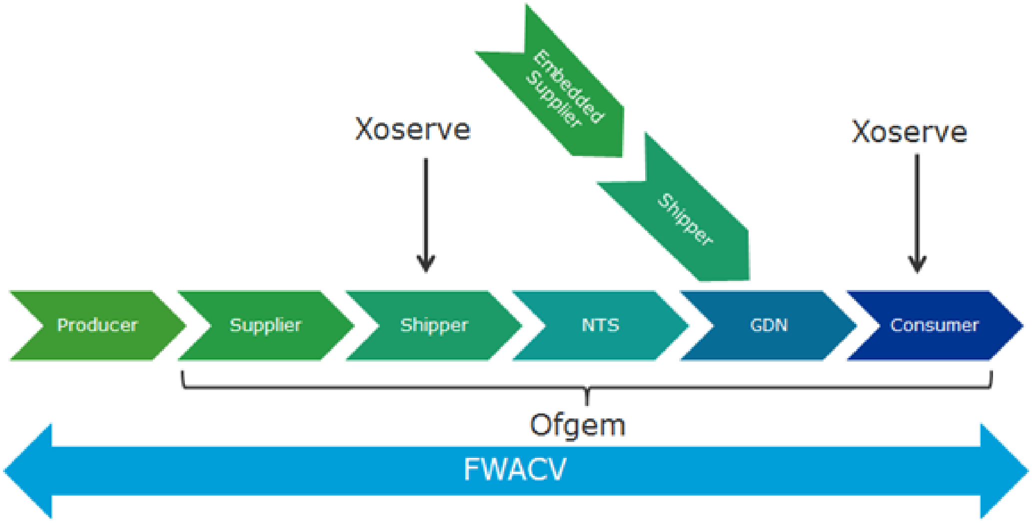


Figure 4.6: Stakeholders impacted by changing the billing methodology

- Through the use of gas quality/component measurement and network modelling this Project will test innovative MPRN-specific CV allocation methodologies to ensure a fairer and more equitable billing methodology for all industry stakeholders.
- The outcome is uncertain as this has not been attempted within the unique regulatory and commercial environment of the GB gas industry.
- The development of a methodology for determining the zone of influence of a particular gas at different levels of demand requires field trials to determine and model how the gas migrates within the LP and MP networks.
- The LP network in GB is unique as the pressure is much lower (<75 mbarg) than that of European gas distribution networks which operate at 2-4 bar.
- The inclusion of novel gas quality sensors and technical solutions that are currently not approved by Ofgem for billing or that could be used to assign or correct an Ofgem approved measurement.

(e) Involvement of other partners and external funding

There are two key participants in the project. National Grid Gas Distribution, NGGDL, is the funding licensee and DNV GL is the project partner.

NGGDL is the largest of the four gas distribution networks and has a central interest in delivering a sustainable gas grid for the future. The commitment to innovation to deliver a low-carbon future is demonstrated by the bio-SNG trials currently being carried out under NIC and the 2016 HyDeploy NIC proposal which seeks to inject hydrogen into the gas network.

DNV GL (formerly GL, Advantica, National Grid and British Gas Research) has a long gas industry heritage. Of relevance to the Project is expertise in network modelling software, gas quality and metering, smart meters and delivering innovation projects under NIA and NIC.

The installation of sensors is likely to be sub-contracted to a specialist integrator with a proven track record of working safely in the gas industry.

(f) Relevance and timing

The reform of the GB billing methodology is both relevant and timely:

- The Government signed up to the Fifth Carbon Budget on 30 June 2016. This commits the UK to adhere to a cap on carbon emissions. The removal of propane addition for low CV unconventional green gases will facilitate carbon reduction.

- The variation of future gas supplies into GB will continue to increase variations in gas quality and the range of CVs injected into the network; this will further challenge the FWACV billing regime.

- The planning process for RIIO GD2 will start in 2018 and interim reports from this Project will inform Ofgem and gas transporters for the final submissions for GD2 in 2021.

- The Project will facilitate the roll-out of a number of NIC projects, see Appendix 14. Five of the projects address gas quality initiatives to de-carbonise the network or reduce gas processing costs. The HyDeploy 2016 NIC bids aims to explore the injection of hydrogen which will reduce the CV of gas supplies. SGN's *Opening Up the Gas Market* project is providing evidence for safely increasing the upper GS(M)R Wobbe Index and hence CV.

- The Project will facilitate the injection of hydrogen into the gas network

- Early visibility of changes to billing by the industry is necessary as any changes will take a considerable period of time to implement. Changes may be required to, for example, the Xoserve billing system, DCC and the Uniform Network Code (UNC). Changes to UNC could trigger changes to client billing systems and procedures at network entry points.

- Smart meters have a 15 year lifetime, so meters installed by 2020 will not be changed out until 2035.

- The CV of shale gas is currently unknown but is likely to vary from traditional NTS gas (see the experience of the US and the range of shale Wobbe Index in Appendix 7); the volumes of shale gas injected into the networks will, under some of the National Grid *Future Energy Scenarios*, be high.

Financial and Carbon Benefits

The financial and carbon benefits of the Project have been calculated using the scenario of the removal of the requirement to propanate low CV gases. The data for the calculations was sourced from the National Grid *Future Energy Scenarios*:

- *Gone Green* – the 2050 carbon reduction target is achieved

- *Slow Progression* – economic conditions restrict the transition to low carbon

- *Consumer power* – high prosperity/consumer power dominates over carbon reduction
- *No Progression* – business as usual with short term focus on traditional fuels

The benefits in terms of NPV have been calculated on a cumulative basis for each of the Future Energy Scenarios for 2020, 2030, 2040 and 2050. A discount rate of 3.5% has been applied for the first 30 years and 3.0% thereafter. Under the *Gone Green* scenario the NPV benefit in 2050 is estimated to be £313M.

The carbon benefits are calculated on a cumulative basis in terms of CO_2 equivalent for each of the Future Energy Scenarios for 2020, 2030, 2040 and 2050. They assume that the energy lost through removal of propane is replaced with equivalent energy from methane. Under the *Gone Green* scenario the cumulative carbon benefit is estimated to be 1.9 million tonnes in terms of CO_2 equivalent.

The assumptions that have been made and the results of the NPV and carbon benefit calculations are shown in Appendix 1.

(g) Demonstration of robust methodology and that the Project is ready to implement

The Project was preceded by a feasibility study jointly supported under NIA by NGGDL and Northern Gas Networks. The results were documented in report 16687 *Definition of Billing Constraints* by DNV GL in December 2015. The scope of work was:

- Network analysis modelling of CV variations
- A study into the stakeholders of the FWACV regime
- A review of previous studies carried out by various parties into billing in the UK
- The impact on billing of varying gas supplies into the UK
- A survey of billing regimes overseas and especially in Europe
- The sensitivity of customer billing to changes in gas quality
- Quantification of the issues surrounding the FWACV billing regime

One of the outputs of the feasibility study was the three scenario methodology outlined in Section 2 above. The network analysis modelling requirements and creation of embedded entry point and within network CV charging areas have been reviewed. These ideas were developed further for the Project through discussions with NGGDL to identify typical and representative biomethane injection points that are suitable locations for a field trial. A study of the gas quality of biomethane inputs in the NGGDL network has been carried out to identify unique markers that would facilitate tracking of biomethane through the network. A survey of analytical equipment has also been carried out with particular emphasis on measuring oxygen.

Section 5: Knowledge dissemination

The Project will conform to the default IPR arrangements set out in Section 9 of the Gas NIC Governance Document.

NGGDL is committed to a knowledge dissemination programme, and sees this as a major component of the value of the project. The learning generated and its relevance, the audience and means of dissemination are laid out below.

5.1. Learning generated and the applicability to other network licensees

NGGDL, as the Network Licensee, and DNV GL, as the Project Partner, are committed to sharing the knowledge generated by this Project. The overarching learning generated is to establish a fair and equitable billing methodology to accommodate the variation in gas quality resulting from the increased diversity of gas sources. This is built up of a number of key learning elements outlined below. Clearly there needs to be a common billing regime for the whole of GB, and so this learning will be relevant to the whole gas industry. The Project is led by NGGDL, and an Advisory Panel would be assembled to facilitate industry engagement and dissemination activities with representatives from key industry stakeholders interested in the outcomes of the Project. Letters of support for the Project are included in Appendix 19.

Gas flow and mixing:	The method of tracking biomethane through the network by measuring oxygen concentration is novel and it avoids invocation of the CV cap as a result of the trials. It will help to develop an improved understanding of how gases flow and mix in the networks.
Network modelling:	The software network analysis tools (e.g. Synergi Gas, GBNA and Graphical Falcon) that are already used by the GDNs for planning and operational analysis will be used to develop an understanding of the variation of CV within a network.
Zones of influence:	The Project will model the zones of influence of embedded supplies over periods of varying demand and therefore enable the more localised allocation of CV for billing.
Network planning:	The methodology developed for the determination of zones of influence and the consequent development of charging areas will be delivered as a generic network modelling procedure that could be implemented in all other Network Licensees' network planning departments.
Smart metering:	Knowledge of how varying gas qualities and gas supplies can be attributed to smart meters will be generated.
Quantitative risk analysis (QRA):	The QRA will be used to identify and control the risks associated with installing, maintaining and removing equipment in the NGGDL network. Risks associated with data security will also be investigated.

Cost benefit analysis:	The high-level cost benefit analysis of each billing scenario will generate commercial knowledge that will inform the recommendations for a future billing methodology.
Industry issues:	Industry engagement will confirm the issues and the appetite of the industry for change.
Of Implementation of the future billing methodology:	Although implementation is outside the scope of the Project, to derive full benefits from the results of the Project the recommended billing methodology needs to be implemented. This will be informed by the detailed learning outcomes developed by the Project, which is not a "business as usual" activity for any of the numerous industry stakeholders. Definition of next steps, including for inclusion into next Price Control which starts in 2021, will therefore be a key learning point.

5.1.1 Knowledge capture

The majority of the learning arises from the development of a procedure for modelling gas flow in the network, tracking CV or a component in the gas, and validation of this methodology by rigorously designed field trails. The assignment of CVs to smart meters is to be investigated.

DNV GL has a unique and comprehensive combination of gas quality, metering, instrumentation, data transfer, software and network analysis expertise. The project team also have significant experience in capturing knowledge and learning, communication via presentations, workshops, conferences and training courses. This will ensure that the Project is scientifically rigorous and robust for all industry stakeholders including consumers.

All information will be captured by the work programme and recorded using a regular reporting structure to provide the basis for dissemination. The Network Licensee is confident that the quality of the captured learning will not only be able to support the assignment of CV data and the possible definition of new charging areas from network modelling, but will derive a validated procedure for all GDNs to implement as appropriate for their network.

5.2. Learning dissemination

5.2.1 The Audience

The audience for dissemination is summarised below.

All:	The purpose of the Project is to develop recommendations for a fair and equitable billing methodology for gas, that will reduce propanation and CV shrinkage that consumers currently pay for.
Gas network owners & operators:	The billing methodology reform will facilitate the creation of embedded connections, and decarbonise network operations. Opportunities will be created to enhance network planning activities including new connections. For the transmission system operator, operational activities and costs may be reduced with less management of gas flows required and less procurement of CV shrinkage gas. The information and timing of the Project and Project results will allow gas transporters to discuss the potential implementation of a billing methodology change ready for RIIO-GD2 price control business plan discussions.
Gas Shippers & Suppliers:	Changes to the gases transported in the network have important impacts on commercial arrangements that the Project seeks to address for gas shippers and suppliers. Although the Project may result in reduced costs of gas to suppliers because of reduced shrinkage overall, investment may be required to implement the new system. Shippers and Suppliers are therefore key stakeholders in the Project. For embedded suppliers of GS(M)R compliant gas, the need to propanate will be removed.
Xoserve:	Changes to IT and business systems may be required in order to implement the new billing methodology, which will make Xoserve a key stakeholder in the Project. Engagement with Xoserve has already commenced.
Regulatory and Standards Bodies:	Implementation of a future billing methodology will require regulatory input. The UNC is likely to change which will require regulatory approval, but this is outside the scope of the Project.
Policymakers:	The Project is an enabler for further embedded entry points in the GDNs and for large scale injection of unconventional gases into the NTS. It is considered to be a prerequisite for the injection of significant quantities of shale gas, hydrogen and low-carbon gas. The Department for Business, Energy & Industrial Strategy is a stakeholder in this Project.

International Bodies:	The Project will be of interest to other countries that are seeking to increase the volume of low-carbon gases injected into their networks, although the relevance will depend on their current network configuration, billing methodologies and regulatory requirements. Energy regulators outside GB are likely to be interested in the Project output. Bodies such as the European Gas Research Group (GERG) are likely to have an interest in the results of the Project.
Customers and consumers:	Ultimately the Project should provide a fairer and more equitable basis for billing. Consumers will benefit overall and are the ultimate stakeholder in the Project, represented by Ofgem and gas consumer bodies.

5.2.2 Means of dissemination

The Project team is committed to disseminating the learning from the Project. This will build on the successful approach to dissemination developed for other NGGDL innovation projects, tailored to the specifics of this project and the needs of its stakeholders, many of whom have already engaged with the Project. A carefully structured communications strategy will be developed collaboratively by NGGDL and DNV GL at the start. This will use a variety of channels for dissemination as shown below.

Industry engagement is key to realising the benefits of the Project. An open engagement process will take place, meaning that responses may come from individuals or organisations with an interest in the results. The Project will not restrict who may engage, although the audience identified above are the most likely participants. It is important to ensure that a reasonably practical solution is found that may be implemented following completion of the Project.

Knowledge Sharing Events:	Industry engagement events, such as briefings and workshops will be a primary means of knowledge sharing. In Work Pack 1 of the Project these will focus on understanding the needs of each stakeholder. Work Pack 4 will disseminate the results of the Project, and help stakeholders understand the benefits of a reformed billing methodology.
Surveys:	In preparing for the industry engagement, due regard will be taken of the large target audience and ensuring that the approach and language adopted is suitable for both a technical and non-technical audience. An initial engagement period is proposed following which a summary of non-commercially sensitive responses will be shared to facilitate transparency. The responses will help to identify any work required to progress to the next stage in the project, or to finalise the recommended future billing methodology.
Project Website:	A dedicated website will be set up by NGGDL for the Project. The website will provide a portal for Project information, including progress and technical reports for key stakeholders.

Journal Articles:	This will include industry and trade journals such as IGEM's "Gas International".
Conferences:	Information will be presented at the annual gas networks innovation conference, as well as other gas and low-carbon conferences.
Industry networks:	Learning from the Project will be shared with industry networks, such as the Leakage and Shrinkage Forum at the Joint Office of Gas Transporters.
Progress & Close out reports:	The six monthly progress reports and the close out reports will be hosted on the dedicated website with links from other sites as required by Ofgem.

Both NGGDL and DNV GL participate in a wide range of innovation projects. This informal network of communication will further enhance the knowledge sharing from the Project, as well as ensuring new learning and good practice is disseminated to make future implementation straightforward.

5.3. IPR

The Project team will comply with the default IPR Provisions. The purpose of the Project is to generate a new billing methodology. Since there must necessarily be a common billing regime across the country there is no intention or opportunity to exploit arising IPR commercially in GB. Copyright will exist on the reports produced as part of this work, but they will be published in the public domain where required for effective knowledge dissemination.

Background IPR, such as that within equipment supplied for the purposes of executing the project (e.g. oxygen sensors) will remain owned by the suppliers as Commercial Products. This will include DNV GL's background IPR in the network modelling tools Synergi Gas, GBNA and Graphical Falcon. These tools are already licenced and used by the GDNs to underpin their network planning and operational analysis. The modelling and analysis work carried out in the Project is to develop the understanding of CV changes and affected zones and will be delivered on the software versions currently available. No additional software capability will be developed as part of the Project. Any modelling procedures that are developed as part of the final recommendation will be software agnostic to allow ready implementation by any gas network operator.

Section 6: Project Readiness

The Network Licensee does not require protection against cost over-runs beyond the default provision of 5% above the funding request. This Project does not give rise to Direct Benefits and so no protection provision is required.

6.1. Evidence of why the project can start in a timely manner

NGGDL is confident in the ability of this Project to deliver due to the level of preparation which has gone into developing this proposal.

Two field trial locations have been carefully selected which, endorsed by experts within and out-with NGGDL, provides the appropriate location for the GB trials; this manages risks and provides maximum opportunity for learning.

DNV GL has wide experience in undertaking gas quality, network modelling, and instrumentation related experimental work, and understands the issues that the gas industry need to see addressed in the Project. The proposal builds on a substantial amount of existing knowledge, combined with more recent foundational work undertaken in the "Definition of Billing Constraints" NIA. A summary of these findings can be found in Section 4(g), above. This material has been used to develop the Project by NGGDL, and particularly DNV GL, who defined the scope and programme of activities required. The "Definition of Billing Constraints" NIA project has identified the primary issues with the FWACV regime, the high level approach to solving the problems, and the key stakeholders. This project was led by DNV GL, and delivered to NGGDL/NGN. In addition, DNV GL has already engaged with instrumentation suppliers/installers to ensure they are aware of the project, and to obtain indicative quotations.

Integral to delivering the field trial programme is the installation of the necessary analytical equipment for the measurement of oxygen concentration in the network, as this has been selected as a suitable biomethane tracer. DNV GL has experience, through the on-going delivery of innovation projects, and many other consultancy projects, of control and instrumentation, data collection, data communications, network modelling software and data processing.

The Project has been carefully designed to negate the need for customer disruption, and so direct engagement will not be required. However industry engagement will be critical to delivering a solution that is accepted by the gas industry. NGGDL has already begun the engagement process, having direct conversations with the other GDNs, National Grid Gas Transmission, and Xoserve, as well as presenting, with DNV GL, at the Joint Office of Gas Transporters' Leakage and Shrinkage Forum in June 2016. Both NGGDL and DNV GL have extensive experience carrying out engagement activities from past projects.

These factors have enabled the development of a carefully structured project, which NGGDL is confident of delivering effectively, on time and within budget. Key aspects of that project are described in the sections below, supported by evidence in the Appendices.

6.1.1 Project plan

A detailed project plan is shown in Appendix 16. This is divided into four key project work packs:

- Work Pack 1: Industry Engagement
- Work Pack 2: Sensors & measurement, network modelling and CV allocation
- Work Pack 3: Assigning a CV to Smart Meters
- Work Pack 4: Industry Engagement on the Options and Cost-benefit Analysis with a Recommended Solution

A stage gate after the first six months will give Ofgem the opportunity to confirm the industry appetite for change, the need for a new billing system and the requirement for the Project to continue. Work Packs 1 and 2 are thus split into two phases – those denoted "a" occur before the stage gate and those denoted "b" occur after stage gate approval.

Within these work packs are the activities necessary to deliver the Project. The activities and their detailed planning has been developed by the experienced team and undergone a careful review process.

The Project plan is assumed to commence on 01 April 2017 and is a three year programme. Under the Ofgem Project Direction, there is a facility to extend the Project by up to six months should this be required for gaining stage gate approval. This will be reviewed prior to commencement of the Project and progress will be monitored through a regular review process by NGGDL throughout delivery. There are no areas of the Project programme which are strictly outside of the control of NGGDL. Alternatives and contingencies for the two biomethane sites selected as the focus of the field trial locations could be available within the NGGDL network if necessary.

6.1.2 Project management and governance

The aim of the Project structure is to manage and deliver the Project safely within budget and programme. It is designed to provide the Network Licensee with the level of control required to meet the requirements of the Ofgem NIC Governance Document, as well as the internal governance requirements of DNV GL (which operates an ISO 9001:2008 certified management system). The Project organisation is summarised in the management diagram in Appendix 15.

National Grid has a well-developed and proven Collaboration Agreement, which has formed the basis for two NIC projects with other partners to date. DNV GL has a long history of working with NGGDL, and has collaborated on many NIA projects with similar Collaboration Agreements, and so together the parties are confident that a contract can be agreed in a timely manner.

The governance framework is in place to oversee and control key decisions and to delegate authority for scope delivery to the NGGDL Project Director. The Project Director will meet with the NGGDL and DNV GL Project Managers on a quarterly basis (and DNV GL Project Director as required) to review Project progress reports, performance against budget, key Project risks and material issues. The role of the NGGDL Project Director will be set out in the Project collaboration agreement.

The NGGDL Project Director is accountable for the successful allocation of Milestones and allocation of stage funding under the NIC allowance. The NGGDL Project Director shall report progress to their Executive Committee. The DNV GL Project Director reports directly to the CEO, DNV GL Oil & Gas, and is ultimately responsible for Project delivery by DNV GL.

Day to day Project management is provided by DNV GL, who is responsible for co-ordinating the normal operations of the project, coordinating and reporting to the NGGDL Project Manager, and acting upon decisions, in particular with relation to budget management, and submitting requests for Milestone completion and sanctions to progress to subsequent project stages. Working project meetings of the participants will be held on a monthly basis. DNV GL is also responsible for the technical management of the field trial programme, including the associated network modelling, throughout the project.

There will be clear agreements setting out the rights and responsibilities of each of the Project participants. These will clearly identify the responsible person or persons for delivery of the project in each organisation and the method of communication to be used.

The Project structure also includes an Advisory Board. NGGDL is currently engaging with the wider industry with the ambition to set up an Advisory Board, and key industry stakeholders have agreed to participate in principle. The purpose of this board is twofold. Primarily it is to ensure that the views of the key industry stakeholders are communicated to the NGGDL Project Manager. It also has an important role in facilitating knowledge dissemination and to underpin subsequent roll out of the future billing methodology.

6.1.3 NGGDL and DNV GL

NGGDL is confident that the team, comprising experienced and expert personnel, is able to deliver the Project. NGGDL's and DNV GL's roles are summarised below.

National Grid Gas Distribution is the Funding Licensee and Project sponsor. It brings its expertise and experience relating to the gas network to the Project, and has undertaken NIA and NIC projects in the past. NGGDL will lead the industry engagement programme.

DNV GL is one of the world's leading gas consultancies. Its UK gas consulting business has a common history with NGGDL as both were formerly part of British Gas, and has undertaken NIA projects in the past and is currently delivering an NIC project. DNV GL is the world-leading provider of software for improving asset performance in the gas industry. Its software (including Synergi Gas, GBNA and Graphical Falcon for network modelling) is used by all the GDNs to support a variety of business critical activities. DNV GL has considerable experience in provision of consultancy services to clients both in the UK and around the world including:

- Network modelling support for Regulators, gas transporters, system operators and service providers.
- Network analysis for planning and operational developments
- Network planning policy and procedure development
- Gas network development masterplans
- Involvement with and input to Network Code e.g. AUGE

- Involvement with IGEM specification development for planning and design of gas networks i.e. IGE/GL/1 and IGE/GL/2.

DNV GL will plan and oversee the field trials, carry out the network modelling and deliver smart meter testing in their own secure labs, as well as analysing the results and preparing the reports. They will provide technical input in the industry engagement programme.

6.1.4 Project Delivery Risk Assessment and Mitigation

The Project will be managed using a structured approach to Project delivery risk. An initial risk register has been drawn up as shown in Appendix 17 which identifies risk, risk management and mitigation plans.

A standardised approach is used for the Project where risks are categorised and assessed in terms of Likelihood and Impact. Likelihood is assessed on a scale from 1 to 5, from low to certain, and Impact assessed between 1 and 5, from low to disastrous. In both cases standardised guidance is used against each category. Mitigation measures against each risk are identified and actions proposed. The risk, on the basis of the mitigation measures being put in place, is reassessed. This tool will be used proactively to manage the Project throughout the delivery phase, with clear responsibility for each action and risk status. It will be updated regularly throughout the Project and will provide the basis for reporting.

The Project risk assessment is grouped into three main categories of risk; namely health and safety risks, technical delivery risks and project risks.

6.1.4 Interface with other Innovation Projects

The Project is considering the changes to the billing methodology necessary to facilitate adoption of new gases and blends more widely into the network. Other innovation programmes are ongoing that study the technical aspects of injecting unconventional gases into the gas grid, all of which depend on the reform of the billing system for their eventual cost-effective implementation (see Appendix 14 for a list of NIC projects). These projects include:

NGN/NGGDL	NIA	2016	HyStart
SGN	NIC	2013	Opening up the Gas Market
WWU	NIA	2015	Future of Energy and Investments in gas Network
NGGDL	NIC Proposal	2016	HyDeploy
SGN	NIC	2015	Real-Time Networks

6.2 Evidence of the measures a Network Licensee will employ to minimise the possibility of cost overruns (Direct Benefits are not applicable to the Project).

6.2.1 Budget Development

A pragmatic approach has been taken to produce a robust cost plan for delivering the project.

The starting point for the cost plan is the careful design of the overall programme, building on good practice from other projects that are being undertaken by NGGDL and

DNV GL. This ensures that not only are the technical activities accounted for, but important facets such as industry engagement are properly considered and costed. Based on a significant amount of technical work, both from the "Definition of Billing Constraints" NIA, as well as the work undertaken to select the field trial sites for this project, and DNV GL's experience delivering the "Real-Time Networks" NIC, a robust activity breakdown has been developed.

The largest cost component comes from the field trials and the installation of the oxygen sensors, flow, pressure and CV measurement devices to be installed in two areas of NGGDL's network. The detailed planning for the field trials themselves forms part of the Project work and so all price risks cannot be eliminated, however DNV GL, and the contractors, are experienced in carrying out this work. The costs include the design of small above ground installations, installation at governor stations, all engineering disciplines including civil, mechanical, control and instrumentation, electrical and software, design appraisal and approval, HAZOP, full documentation and drawings, build, factory testing and installation. All works will be carried out in accordance with NGGDL's processes and procedures.

In addition to the overall technical scope, the Project delivery has been thoroughly considered and builds on the experience from other NICs projects. Third parties have been approached for costs for individual elements such as oxygen analysers, based on specifications developed by DNV GL. National Grid has costed the support they will provide for installation of equipment based on their experience.

The consolidated costs have been reviewed by NGGDL and DNV GL. In particular, the risk register for the Project has been reviewed to identify areas that require allowances to be made against specific activities.

By these means, and through an internal review process, there is confidence, not only that the scope is well defined and comprehensive to deliver the project, the associated costs are considered to be robust.

6.2.2 Budget Management

The project will be carefully managed to ensure that it delivers to budget. This will be overseen by the NGGDL Project Manager.

The DNV GL Project Manager will consolidate and track project costs from the team and suppliers. These will be provided as part of the wider monthly project reporting process to the Project Director at NGGDL.

National Grid already has in place the governance processes to manage a separate NIC account and provide the necessary traceability of invoices and payments made.

Budgets will be reviewed regularly by the NGGDL Project Director, to minimise the risk of cost overruns.

6.3 A verification of all information included in the proposal (the processes a Network Licensee has in place to ensure the accuracy of information can be detailed in the appendices)

The data presented in this proposal has been verified. In general, third party evidence has been used to support assertions and the entire proposal has been reviewed by NGGDL. The following table summarises the areas of the project and the verification process followed.

Programme Scope	This was developed early in the proposal, drawing on the experience from the "Definition of Billing Constraints" NIA. It underwent a substantial review and sign off process by DNV GL and NGGDL.
Technical Programme & Budget	The overall technical programme was developed by DNV GL and was subject to its internal verification and approval process. Dialogue with NGGDL and network modelling by DNV GL enabled the field trial sites to be identified. Consideration was made for a means of tracking CV through the network, and oxygen concentration agreed to be the most effective and least disruptive from a technical, legal and commercial perspective.
Installation Programme & Budget	Turnkey solutions for the procurement and installation of the field trial equipment were investigated by DNV GL and outline quotations obtained. A full procurement process, in line with NGGDL and DNV GL policies, will be undertaken as part of the Project.
Field Trial Programme & Budget	This was developed by DNV GL based upon past experience on other NIC projects, and reviewed by NGGDL.
Smart Meter Programme & Budget	This was developed by specialists at DNV GL's smart meter laboratory facility, based upon past experience, and reviewed by NGGDL.
Dissemination	Figures were developed by NGGDL against the costs under other NIC projects.
Financial Benefits	NGGDL undertook the assessment of financial benefits, building on its Future Energy Scenarios work, supplemented by 3rd party material. This was reviewed by DNV GL.

6.4 How the Project plan would still deliver learning in the event that the take up of low carbon technologies and renewable energy in the Trial area is lower than anticipated in the Full Submission

This project will provide valuable learning even without the uptake of low-carbon technologies. The field trials themselves will allow learning to be created regarding gas flow and mixing in networks, and will enable the GDN's network modelling tools to be further validated under current configuration and flow conditions. This will be valuable from a network planning perspective, especially as the number of embedded entry points increases, and the complexity of the networks develops. Moreover the distributed oxygen sensing equipment and related communications systems are new to the gas networks, and will provide valuable data on the concentration of this gas in the network.

The work pack to assign CV data to smart meters will be the first step to attributing a CV to individual meters. Consideration will be given to how this CV can be linked to consumer bills. Valuable learning is expected to result that will be useful more widely for the smart meter roll out.

The industry engagement activities are in themselves expected to generate learning regarding the perceived impact of change on the gas industry, the issues, and the appetite of the industry for change. This will be useful to inform future programmes or work, including the implementation of the future billing methodology, which would be required for the adoption of non-renewable unconventional gases, such as shale gas.

6.4 The processes in place to identify circumstances where the most appropriate course of action will be to suspend the Project, pending permission from Ofgem that it can be halted.

The Project has been carefully planned and reviewed by NGGDL for deliverability, so project suspension or termination is considered unlikely.

The NGGDL Project Manager will keep the Project progress and accrual of benefits under review (the Milestones being illustrated in Table 6.1), and more generally, will have the authority to suspend the Project in the event that:

- Insufficient progress is being made compared to the Project Plan.
- It cannot be delivered within its budget and additional funds cannot be raised.
- Risks are identified which cannot be mitigated and make delivery of the Project objectives unlikely.

After any suspension, Ofgem will be approached to discuss and agree termination of the Project. Under the terms of the Project Collaboration agreement, specific provisions will be defined for dealing with termination of the work in this event. The Project milestones are shown in Table 6.1.

Milestone	Work Pack	Milestone Description	Date
1	**2b**	**Quantitative risk analysis**	24/11/17
Purpose		Define quantitative risk analysis approach for major risks during project technical delivery	
Output		Draft report on QRA approach and first version of "live" QRA document for update during project delivery	
Review		NGGDL to review and agree QRA approach and first version of "live" QRA document	
Acceptance		NGGDL to accept/reject final report and first version of "live" QRA document	
2	**1a**	**Terms of reference for industry engagement**	05/05/17
Purpose		Define terms of reference for industry engagement	
Output		Draft terms of reference document	
Review		NGGDL to review and agree changes with DNV GL for final document	
Acceptance		NGGDL to accept/reject final document	
3	**2a**	**Detailed specification of field trial at**	22/12/17

Milestone	Work Pack	Milestone Description	Date
		Chittering	
Purpose		Undertake detailed specification for Chittering field trial	
Output		Draft specification for Chittering field trial	
Review		NGGDL to review and agree changes with DNV GL for final document	
Acceptance		NGGDL to accept/reject final documents	
4	**2a**	**Detailed specification of data collection**	22/12/17
Purpose		Undertake detailed specification for data collection from field measurements around Chittering and Hibaldstow	
Output		Draft copy of detailed data collection specification	
Review		NGGDL to review agree changes with DNV GL for final document	
Acceptance		NGGDL to accept/reject final documents	
5	**2a**	**Detailed specification of field trial at Hibaldstow**	22/12/17
Purpose		Undertake detailed specification for Hibaldstow field trial	
Output		Draft specification for Hibaldstow field trial	
Review		NGGDL to review and agree changes with DNV GL for final document	
Acceptance		NGGDL to accept/reject final documents	
6	**3**	**Define specification for laboratory simulation of smart meter CV data collection**	22/12/17
Purpose		Undertake detailed specification for simulation collection/use of CV data by smart meters	
Output		Draft copy of detailed specification of simulation of CV collection/processing by smart meters	
Review		NGGDL to review detailed specification and agree changes with DNV GL for final document	
Acceptance		NGGDL to accept/reject final documents	
7	**2b**	**Installation of measurement equipment at Chittering**	07/09/18
Purpose		Undertake installation of measurement equipment in networks around Chittering	
Output		Completed FAT and SAT for all measurement sites	
Review		DNV GL to sign-off FAT and SAT results and recommend acceptance/rejection to NGGDL	
Acceptance		NGGDL to accept/reject final documents	
8	**2b**	**Installation of measurement equipment at Hibaldstow**	07/09/18
Purpose		Undertake installation of measurement equipment in networks around Hibaldstow	
Output		Completed FAT and SAT for all measurement sites	
Review		DNV GL to sign-off FAT and SAT results and recommend acceptance/rejection to NGGDL	
Acceptance		NGGDL to accept/reject final documents	

Milestone	Work Pack	Milestone Description	Date
9a	**1a**	**Undertake phase 1 industry engagement and compile summary**	11/08/17
Purpose		Undertake phase 1 industry engagement and collate responses for stage gate submission	
Output		Draft copy of phase 1 industry engagement summary	
Review		NGGDL to review and agree final summary document with DNV GL	
Acceptance		NGGDL to accept/reject final summary document for submission to Ofgem as part of SDRC9.1a	
9b	1b	Undertake phase 2 industry engagement and compile summary	30/3/18
Purpose		Phase 2 industry engagement report to include an update on continuing industry liaison	
Output		Draft copy of phase 2 industry engagement summary	
Review		NGGDL to review and agree final summary document with DNV GL	
Acceptance		NGGDL to accept/reject final summary document	
10	**2b**	**Interim report on progress of field trials**	11/12/18
Purpose		Collate interim field trial results and report on findings	
Output		Draft report detailing interim field trial results and findings	
Review		NGGDL to review interim progress report and agree changes with DNV GL for final document	
Acceptance		NGGDL to accept/reject final documents	
11	**3**	**Smart meter laboratory trials and report**	08/11/19
Purpose		Report on findings of smart meter results	
Output		Draft report detailing smart meter laboratory results and findings	
Review		NGGDL to review report and agree changes with DNV GL for final document	
Acceptance		NGGDL to accept/reject final documents	
12	**2b**	**Report on completion of field trials**	15/11/19
Purpose		Collate field trial results and report on findings	
Output		Draft report detailing field trial results and findings	
Review		NGGDL to review report and agree changes with DNV GL for final document	
Acceptance		NGGDL to accept/reject final documents	
13	**2b**	**Report on completion of network modelling results for pragmatic and composite charging areas**	27/12/19
Purpose		Outline options and methods for assigning CV to charging areas using field trial results	
Output		Interim update and final draft document for options and methods for assigning CV to charging areas	

Milestone	Work Pack	Milestone Description	Date
Review		NGGDL to review documents detailing findings and agree changes with DNV GL	
Acceptance		NGGDL to accept/reject final document	
14	**4**	**Industry engagement and knowledge dissemination**	06/03/20
Purpose		To engage with all stakeholders and report industry responses	
Output		Carry out industry engagement and collate responses in a draft report	
Review		NGGDL to review summary and agree changes with DNV GL for final report	
Acceptance		NGGDL to accept/reject final report	
15[1]	**4**	**Recommendations for future billing methodology**	31/3/20
Purpose		Collate all project findings and derive recommendations for future billing methodology based on a high-level CBA	
Output		Draft document defining recommendations for future billing methodology	
Review		NGGDL to review recommendations and agree changes with DNV GL for final document	
Acceptance		NGGDL delivery of report to Ofgem	

Table 6.1: Summary of Project milestones

[1] An initial cost benefit analysis will form part of milestone 9a

Section 7: Regulatory issues

For the purpose of the Project and proof of concept there are no changes required at a regulatory level or any exemptions or deviations from current licence or adherence to industry policies/standards. The Project has been carefully designed to deliver the output with the minimum of change to Regulations, licence conditions, industry policies and standards and consumers.

The controls put in place during Project design that minimise regulatory issues are listed in Table 7.1.

Issue	Project Design
Regulations	No CV capping incurred and FWACV billing system to remain in force throughout Project delivery. Flow of biomethane through the network to be tracked by concentration of oxygen in the gas. Gas to remain GS(M)R compliant throughout.
Gas Transporters Licence	No change required. Normal operations to be monitored by additional measurements and network modelling.
Consumers	Testing of allocation of a CV to smart meters to be carried out in DNV GL Technical Assurance Laboratory which mimics DCC and will host the SMETS2 smart meters. Installation of sensors to be carried out at about 40 existing NGGDL governor stations around the Chittering and Hibaldstow biomethane injection points to minimise impact on public. Installation of about 15 sensors around Chittering to be housed in small new kiosks (or existing kiosks if available) to minimise impact on public and the local environment. No interruption to the gas supply. Installations to be decommissioned at the end of the Project
Industry Policies and Procedures	All installation on the gas network to be compliant with NGGDL existing policies and procedures and executed under existing Safe Control of Operations requirements.

Table 7.1: Summary of Project design measures to minimise regulatory issues

Post Project, the Future Billing Methodology is likely to recommend changes that will impact on charging areas including the Uniform Network Code and other industry procedures and IT systems involved in the billing processes.

Section 8: Customer Impact

The Project has been carefully designed to have minimal impact on consumers:

- It is not envisaged that any interruption to the gas supply will be required. All equipment can be installed safely while the gas is flowing.
- The installation of oxygen monitoring equipment will remove the need to change the way the network or the embedded biomethane suppliers operate. The installations within governor stations will have minimal impact on the environment as they are likely to be housed within existing NGGDL buildings and enclosures.
- The installations at street level around Chittering are being designed to be as small and discreet as possible.
- The testing of smart meters will be carried out in a laboratory environment using communications and meters that mimic DCC as closely as possible.
- There is no requirement to contact or interact with individual consumers during Project delivery.
- As part of the stakeholder engagement process, it is envisaged that consumers may be represented by a gas consumer group.
- The installation and testing of measurement sensors at both governor stations and within the network is similar to other routine operations and should not lead to any interruptions to the gas supply.

When carrying out work on the gas network, there is always the small risk that, due to unforeseen circumstances, there may be an unplanned interruption to the gas supply. To mitigate the potential impact of the works on gas consumers, the general public, businesses and other utilities near to the installation sites, a QRA will be carried out which will use a risk matrix approach as follows:

- Identify the hazards introduced through the delivery of the Project,
- Assess the potential impact to health and security of supply,
- Identify any mitigation and control measures, and
- Record where additional mitigation should be considered.

The initial risk assessment would be undertaken by desktop hazard identification and reviewed by a joint workshop between DNV GL and the NGGDL Project team. The risk assessment will be recorded in a spreadsheet which will be a live document held and updated by DNV GL during the Project. The outcomes from the QRA will be communicated to the sub-contractor(s) carrying out the installation work. To ensure that the sub-contractor(s) has/have the necessary competencies and safety record, as part of the procurement process, DNV GL is required and committed to achieving, maintaining and promoting ethical, responsible, safe and sustainable conduct at all times.

Section 9: Successful Delivery Reward Criteria (SDRCs)

This section sets out the proposed Successful Delivery Reward Criteria (SDRC), each under a subsection labelled 9.1 to 9.5. The SDRC are genuine actions linked to outputs of the project with a realistic but challenging deadline. The following subsections set out each criterion and clearly state the evidence that it is proposed Ofgem should use to assess performance against criterion. Note all SDRC delivery dates refer to the end of the calendar month.

9.1a. Industry Engagement – Phase 1

The Industry Engagement Phase 1 will take place in Work Pack 1a and this SDRC will provide Ofgem with evidence of the following:

- The Terms of Reference for the Industry Engagement
- The numbers and types of participants in the Industry Engagement
- A compilation of the output from workshops, questionnaires and meetings held during the Industry Engagement (Phase 1)
- Initial cost benefit analysis
- Requirement for the validation of the network modelling

This SDRC will be based on milestone 9a of the Full Submission and will be delivered to Ofgem by NGGDL on 11 August 2017.

The phase 1 report to Ofgem will be in line with condition 2 set out in section 3 of the Project Direction. The Project will not proceed Ofgem until consent is given in line with condition 2.

9.1b Industry Engagement – Phase 2

The Industry Engagement Phase 2 will take place in Work Pack 1b and this SDRC will provide Ofgem with evidence of the following:

- Phase 2 industry engagement report to include an update on continuing industry liaison following Phase 1

This SDRC will be based on milestone 9b of the Full Submission and will be delivered to Ofgem by NGGDL on 31 March 2018.

9.2. Novel tracking of unconventional gases by measurement

The novel tracking of unconventional gases by measurement will involve the installation and collation of field trial measurements. This SDRC will provide Ofgem with evidence of:

- The installation of additional sensors on the gas network in governor stations and at street level
- The efficacy of measuring oxygen content, pressure and flow to support the validation of network modelling for determining the distribution of biomethane in LP and MP networks

This SDRC will be based on milestone 12 and will be delivered to Ofgem by NGGDL on 31 December 2019.

9.3. Report on novel validation of network modelling for embedded and network charging areas

The novel validation of network modelling for embedded and network charging areas will use zonal analysis of pressure, flow and oxygen tracking measurements from the field trials. This SDRC will provide Ofgem with evidence of:

- How to analyse oxygen, pressure and flow data from the field trials using network modelling techniques
- Options and methods for assigning CV to charging areas for the *Pragmatic* and *Composite* scenarios

This SDRC will be based on milestone 13 and is planned to be delivered to Ofgem on 31 December 2019.

9.4. Report on Smart Metering Laboratory Trials

The smart metering laboratory trials will be carried out at the DNV GL Technical Assurance Laboratories in Peterborough. Several CV measurement devices will be installed in the network field trial which would transfer CV to the smart meters. This SDRC will provide Ofgem with evidence of:

- The transfer of CV to smart meters via a mimic of DCC
- Options and further developments required for the future transmission of CV from smart meters to the billing process

This SDRC will be based on milestone 11 and will be delivered by NGGDL to Ofgem in 31 December 2019.

9.5. Future Billing Methodology Recommendation

The Project will report on Future Billing Methodologies and cost benefits of the three scenarios *Pragmatic, Composite and Ideal* concluding with a recommendation and high level implementation plan. This SDRC will provide Ofgem with evidence of:

- The Project findings through a collation of the outputs from Work Packs 1 to 4
- The Project recommendations and how these were derived including cost benefit analyses
- High-level implementation plan of the recommendations

This SDRC will be based on milestone 15 and will be delivered by NGGDL to Ofgem on 31 March 2020.

Appendix 1. Benefits Tables

Net Present Value Project Benefits

The NPV calculations focussed on savings from the removal of the incremental cost of propane currently required to enrich low CV gases that are GS(M)R compliant. The quantities of propane predicted to be injected were taken from the National Grid *Future Energy Scenarios*. The following assumptions have been made:

- Benefits would arise from 2017 (but would not materialise in reality until post-implementation of the Project).
- Bio-SNG gas will require propanation in the same proportions as biomethane.
- Shale will require propanation in the same proportion as biomethane.
- Price of propane assumed to be static at 2.27 p/kWh (increased demand would significantly increase price).
- Price of natural gas assumed to be static at 1.3 p/kWh
- 2050 assumes flat for last decade.
- Initial project costs of £5 million are proportioned between shale gas and biomethane according to the discounted BCM benefit delivered by 2050
- The Ofgem discount rate of 3.5% between 2017 and 2047 (year 30). A discount rate of 3.0% has been used for 2048 - 2050 (incl.).
- Benefits are quoted in millions of GBP.

Table A1.1 shows a summary of the projected NPV Project benefits for each of the scenarios.

NET PRESENT VALUE (NPV) BENEFITS						
NB: Benefits based on FES % demand x avoided incremental cost of propane @ £0.8m per 0.25% demand			**2020**	**2030**	**2040**	**2050**
GONE GREEN	Shale Gas	£m (Cum.)	-	-	-	-
	Bio-methane/syn	£m (Cum.)	9.76	93.05	220.26	313.22
	Total	£m (Cum.)	**9.76**	**93.05**	**220.26**	**313.22**
SLOW PROGRESSION	Shale Gas	£m (Cum.)	-	-	-	-
	Bio-methane/syn	£m (Cum.)	6.47	49.44	118.76	172.82
	Total	£m (Cum.)	**6.47**	**49.44**	**118.76**	**172.82**
NO PROGRESSION	Shale Gas	£m (Cum.)	-	248.10	642.03	925.72
	Bio-methane/syn	£m (Cum.)	3.41	11.49	17.31	21.49
	Total	£m (Cum.)	**3.41**	**259.60**	**659.34**	**947.21**
CONSUMER POWER	Shale Gas	£m (Cum.)	-	529.38	1,410.27	2,065.63
	Bio-methane/syn	£m (Cum.)	6.16	45.26	102.60	147.99
	Total	£m (Cum.)	**6.16**	**574.64**	**1,512.88**	**2,213.62**

Table A1.1: NPV Project benefits

The benefit cost ratios are summarised in Table A1.2.

BENEFIT COST RATIO			2020	2030	2040	2050
GONE GREEN	**Total**	£m	**2.0**	**19.0**	**45.0**	**63.9**
SLOW PROGRESSION	**Total**	£m	**1.3**	**10.1**	**24.2**	**35.3**
NO PROGRESSION	**Total**	£m	**0.7**	**53.0**	**134.6**	**193.3**
CONSUMER POWER	**Total**	£m	**1.3**	**117.3**	**308.8**	**451.8**

Table A1.2: Project benefit cost ratios

Cumulative Carbon Benefits

The cumulative carbon calculations focussed on the removal of the requirement to propanate low CV GS(M)R compliant gases. The quantities of propane predicted to be injected were taken from the National Grid *Future Energy Scenarios*. The following assumptions have been made:

- Benefits would arise from 2017 (but would not materialise in reality until post-implementation of the Project).
- Bio-SNG gas will require propanation in the same proportions as biomethane.
- Shale will require propanation in the same proportion as biomethane.
- Carbon equivalent emissions are from 2015 data and were taken from the Digest of United Kingdom Energy Statistics published by the Department for Business, Energy and Industrial Strategy on 28 July 2016 (known as DUKES 2016):
  - Natural gas carbon equivalent was 0.184 kg(CO_2)/kWh
  - Propane (LPG) carbon equivalent data was 0.214 kg(CO_2)/kWh
- Propane was replaced with the equivalent (in terms of energy) by methane.

Table A1.3 shows a summary of the cumulative carbon benefits for each of the scenarios.

Cumulative carbon benefit (tCO2e)		2020	2030	2040	2050
GONE GREEN	Shale	-	-	-	-
	Biomethane	36,882	440,391	1,143,199	1,898,737
		36,882	440,391	1,143,199	1,898,737
SLOW PROGRESSION	Shale	-	-	-	-
	Biomethane	23,904	234,949	623,102	1,062,523
		23,904	234,949	623,102	1,062,523
NO PROGRESSION	Shale	-	1,185,837	3,424,144	5,729,738
	Biomethane	12,503	45,785	79,796	113,804
		12,503	1,231,623	3,503,940	5,843,542
CONSUMER POWER	Shale	-	2,570,275	7,602,675	12,928,944
	Biomethane	23,305	206,245	533,306	902,193
		23,305	2,776,520	8,135,982	13,831,137

Table A1.3: Project cumulative carbon benefits (tonnes of CO_2 equivalent)

The capacity released table could not be included due to:

- Uncertainty over the pressure tier for the injection of large volumes of gas. For example, shale gas may be produced in large volumes and could therefore be injected into the LDZs and/or the NTS. This means it is not possible to be definitive about the level of NTS exit capacity that could be released as a result of the Project
- The benefits that the Project is designed to unlock are universal across the GDNs and are not quantifiable by NGGDL in isolation

Appendix 2. GB Local Distribution Zones and the Three Project Scenarios

The schematic of Figure A2.1 shows the potential transition from the current FWACV billing methodology which is based on 13 LDZs. The *Pragmatic* solution creates charging areas within the current LDZ structure. The *Composite* solution creates new charging areas based on location (possibly post code or Ordnance Survey coordinates). The *Ideal* solution assigns a CV to individual meters.

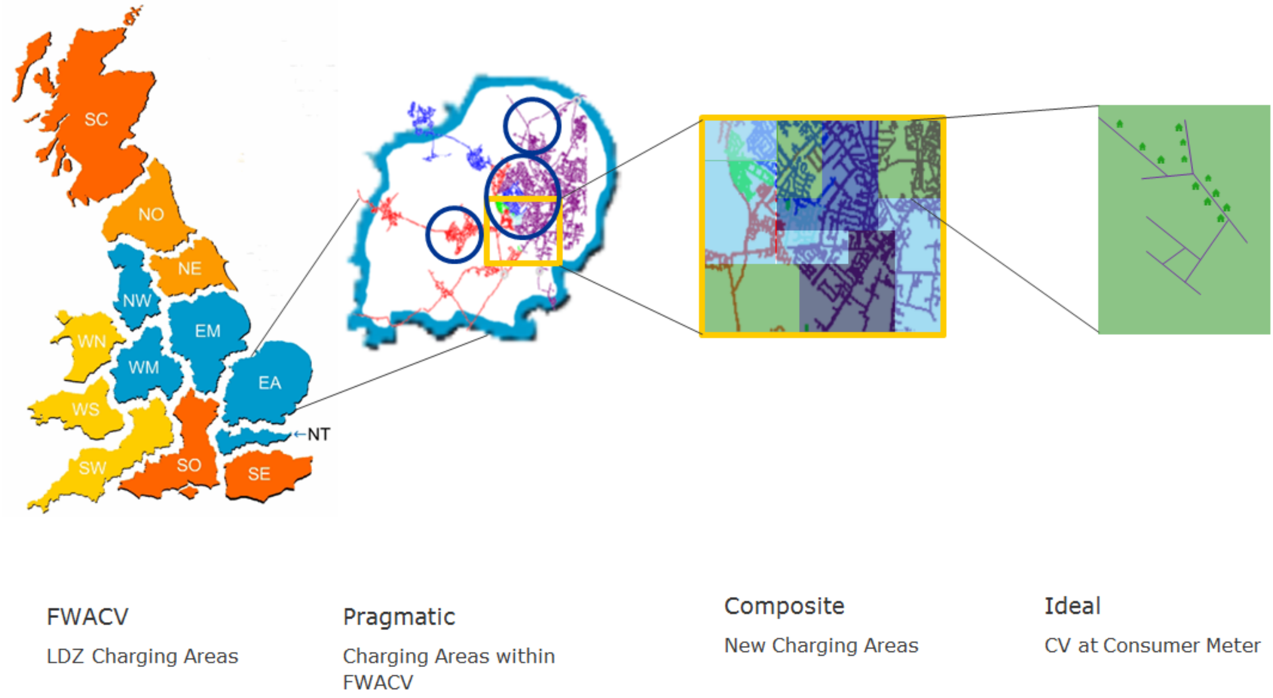


Figure A2.1: Schematic diagram to show the transition from FWACV to potential future billing methodologies

A list of the 13 LDZs is shown in Table A2.1 together with the GDN that operates the gas supply network within the LDZ.

Gas Distribution Company	LDZ
National Grid Gas Distribution	East Anglia, EA East Midlands, EM North West, NW North Thames, NT West Midlands, WM
Northern Gas Networks	North, NO North East, NE
SGN	Scotland, SC Southern, SO South East, SE
Wales and West	South West, SW Wales North, WN Wales South, WS

Table A2.1: List of GDNs and LDZs assigned to each gas transporter

Appendix 3. Customer Assignment by Postcode and Ordnance Survey

For the *Pragmatic* and *Composite* scenarios, an attribute or zone identifier for grouping consumers to the new charging area needs to be explored. One possible option is to use postcode data.

The assignment of customers using postcodes has the advantage of being linked to a particular road (and hence gas supply pipe) and the granularity of customer assignment can be varied. Using the postcode LE11 3GR, as an example, the outward code is LE11 and the inward code is 3GR. These are further subdivided as shown in Figure A3.1 and the number of each denoted.

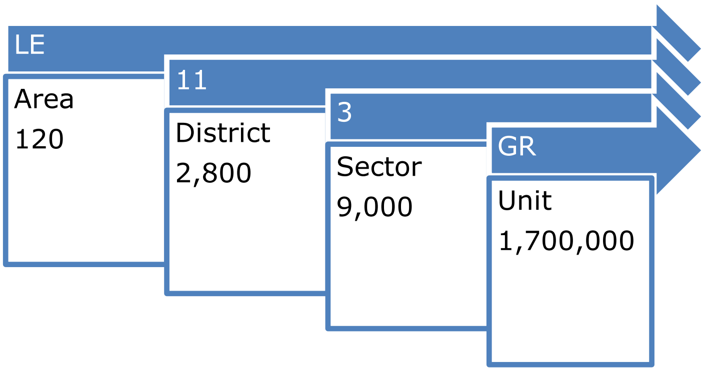


Figure A3.1: Sub division of post codes and example for LE11 3GR

Postcodes, however, do change (typically 2,750 created and 2,500 terminated every month) but Ordnance Survey coordinates remain constant. However, an Ordnance Survey coordinate is likely to be located on the building itself which may not necessarily then map accurately to the correct gas supply in the road serving that property – the nearest road in terms of distance may be the one behind the property. It is believed that the Data Communications Company (DCC) who will handle, establish and manage the data and communications network to connect smart meters to the business systems will be using Ordnance Survey coordinates.

Appendix 4. Department of Business, Energy and Industrial Strategy – Structure, Agencies and Public Bodies

The Department of Energy & Climate Change (DECC) previously worked to make sure the UK has secure, clean, affordable energy supplies and promote international action to mitigate climate change. DECC is a ministerial department that was supported by 8 agencies and public bodies. DECC has, of July 2016, been superseded and replaced by the Department of Business, Energy and Industrial Strategy (BEIS). Figure A4.1 illustrates the relationship between the various bodies within BEIS.

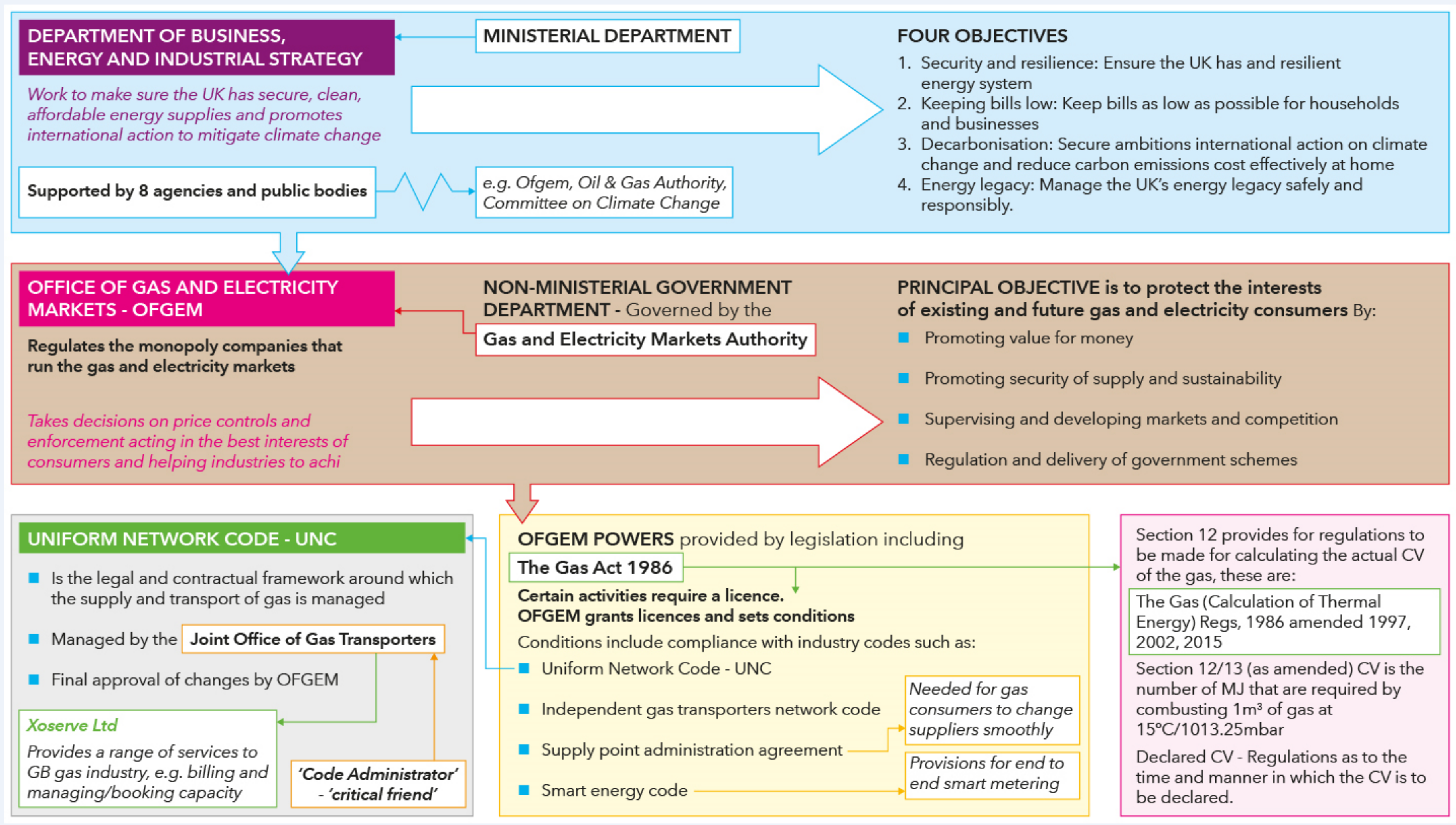


Figure A4.1: Relationship between the various bodies within BEIS

Appendix 5. Outline Terms of Reference for Industry Engagement

The Terms of Reference for the Industry Engagement should articulate the scope and limitations of the Project. They should define the framework and act as a point of reference throughout the project. The Terms of Reference are a governance document that determines the relationships between all the Project stakeholders. As a minimum, it is likely that the Terms of Reference would cover:

- Project background and context – brief description of the project (previous work completed under NIA) and the surrounding context of the business needs for a reformed billing methodology.
- Purpose and objectives of the engagement – explain why the Project is being carried out, what triggered it and how the results will be used.
- Audience for the engagement – who is commissioning it, who is expected to act on the results, how the evaluation will be used and the results disseminated.
- Engagement issues and key questions – the evaluation criteria should be clearly identified and may form an evaluation matrix. In terms of the industry billing system, there are likely to be generic issues of:
    a. Efficiency – current and future use of resources.
    b. Relevance – whether change can deliver the desired benefits.
    c. Effectiveness – the likelihood of realising the project outputs.
    d. Impact - a measure of the costs and benefits of changing the billing methodology including system and legislative impacts.
    e. Future-proofing – whether there is a sustainable outcome for the gas industry going forward.
- Methodology – data collection methods, geographical scope, data analysis, timelines, stakeholder involvement to optimise realisation of benefits.
- Profile of the evaluation team – covering technical knowledge of the commercial systems, experience across the gas chain, knowledge of future gas supplies, etc.
- Outputs and deliverables including a list of key deliverables and deadlines.
- Evaluation timetable – this should be realistic.

Appendix 6. Use of Network Modelling to Investigate Zones of Influence

The images shown in Figure A6.1, taken from network modelling simulations, are indicative of the possible zone of influence of an unconventional gas source from a high level of demand, an 'average' level of demand and through to a very low level of demand: the red coloured pipes indicate gas from an unconventional supply source.

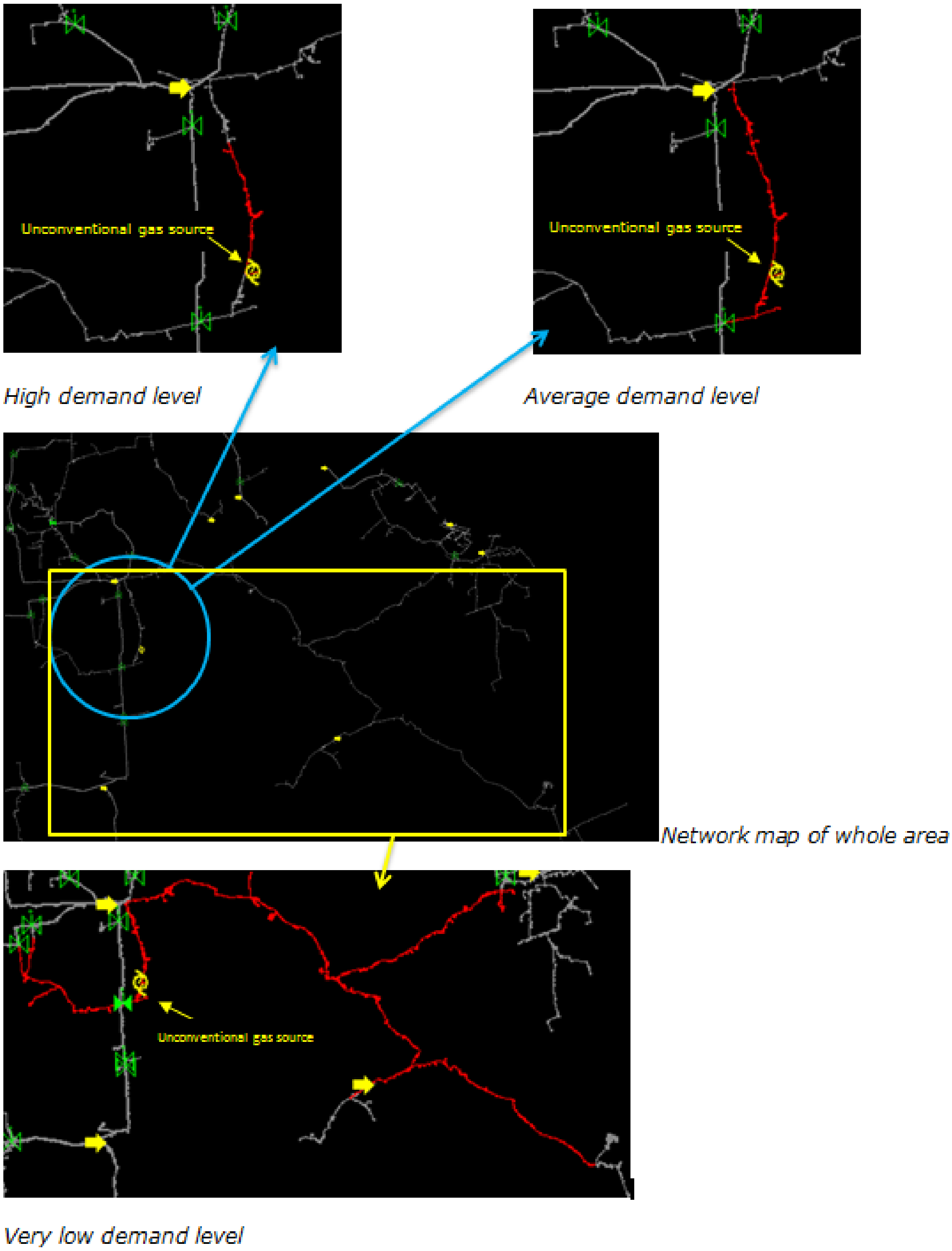


Figure A6.1: Examples of indicative possible zones of influence of an unconventional gas

Through the analysis of measured data and its application within network modelling tools, the Project aims to demonstrate that the CV of the gas received by customers within the zone of unconventional gases differs from the prevailing CV in the area. Assuming that the unconventional gas is of a lower CV than conventional gas (which is typically the case), then customers within the zone of unconventional gases will have higher gas bills as they will need to burn a greater volume of gas as the energy of the gas they are receiving is lower. The reverse relationship would apply if the unconventional gas is of a higher CV than the prevailing CV in the area.

As the level of demand changes and the operation of the network changes, the zone of influence of any supply will change. The use of measurements aims to build up a profile of how often areas of a network are impacted by gas from an unconventional supply. From this understanding of the flow of the gas within the network, a time based probability of the impact of an example biomethane site can be generated and a fixed zone boundary identified for the purposes of billing.

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Appendix 7. Differences in the Gas Quality Specification of NTS Gas and Biomethane

NTS Gas

The composition of NTS gas supplies should conform to the National Grid Gas Transmission Ten Year Statement. A summary is given in the Table A7.1.

Component	Quality Requirement
Hydrogen sulphide	Not more than 5 mg/m^3
Total sulphur	Not more than 50 mg/m^3
Hydrogen	Not more than 0.1% (molar)
Oxygen	Not more than 0.001% (molar)
Hydrocarbon dewpoint	Not more than -2°C at any pressure up to 85 barg
Water dewpoint	Not more than -10°C at 85 barg
Wobbe number (real gross dry)	The Wobbe number shall be in the range 47.20 to 51.41 MJ/m^3
Incomplete combustion factor	Not more than 0.48
Soot index	Not more than 0.60
Carbon dioxide	Not more than 2.5% (molar)
Contaminants	The gas shall not contain solid, liquid or gaseous material that might interfere with the integrity or operation of pipes or any gas appliance, within the meaning of regulation 2(1) of the Gas Safety (Installation and Use) Regulations 1998, that a consumer could reasonably be expected to operate. Ofgem agree that no NGG action required.
Organo halides	Not more than 1.5 mg/m^3
Radioactivity	Not more than 5 becquerels/g

Table A7.1: Summary of gas quality requirements in the Ten Year Statement

Biomethane Exemption

The HSE has announced a class exemption to GS(M)R to allow network conveyance of gas with an oxygen content ≤ 1% (molar) at pressures up to 38 bar. The exemption certificate will be held by HSE.

This now means that gas conveyors will no longer need to request bespoke exemptions to GS(M)R where:

- Pipes used to convey gas with an oxygen content up to and including 1% (molar) are operated at pressures below 38 bar; and,
- The gas conveyed complies with all other requirements and prohibitions imposed by regulation 8(1) of the GS(M)R.

In the absence of a current industry standard for biomethane quality the gas distribution networks (GDNs) have all confirmed that, as part of their network entry controls, they will insist on the application of activated carbon filters by biomethane producers prior to network injection of biomethane. HSE is satisfied that this precautionary approach will ensure the removal of contaminants to a safe level until such time as an applicable industry standard becomes available.

Appendix 8. Legal Constraints During Project Delivery

Summary of Legal Opinion

A summary of legal opinion from NGGDL, following his study of the Gas (Calculation of Thermal Energy) Regulations is indicated below:

- Energy transported through the NGGDL network must be calculated in accordance with either paragraph 4 or 4A, with 4A looking the more appropriate methodology where there are a number of inputs in a charging area (see extract from the Regulations below).
- There is no derogation. Any breach is punishable either by prosecution with a potential penalty of an unlimited fine, if convicted, or by enforcement action under the Gas Act on the basis of a breach of a relevant provision.
- This does not prevent our turning off propanation to carry out the proposed tests, but we would have to take the consequences if the application of the Regulations affected our charges to customers.

In theory there are two alternatives:

(a) Seek a letter from Ofgem that they would not take enforcement action.

(b) Seek an amendment to the Regulations.

Even though the Project aims to lead to a more accurate billing methodology for the actual energy consumed in the long-term, it difficult to envisage Ofgem agreeing to either course of action because of the immediate customer impact. Given that the operation of the 4A CV cap at LDZ level, and the significantly disproportionate impacts that could arise in terms of LDZ under-billing and increased NTS shrinkage, the de-propanation approach to gas source tracing would not be practicable for the NIC Future Billing Methodology project.

The project team has considered the option of ceasing propanation but have chosen an alternative approach of tracing the gas in order to avoid the negative impacts on customers.

Extract from the *Gas (COTE) Regulations*

An extract from the 1997 No. 937 *GAS - The Gas (Calculation of Thermal Energy) (Amendment) Regulations 1997 Calculation of daily calorific values—alternative method* is reproduced below:

4A.—(1) The daily calorific value of gas conveyed to any take off point situated in a charging area in respect of a gas day shall be the lower of:

(a) the area calorific value; and

(b) the calorific value obtained by adding one megajoule per cubic metre to the lowest of:

(i) any of the average calorific values determined on the gas day by the public gas transporter pursuant to directions given under regulation 6(a) and (b)below on the basis of samples of gas which is a commingling of gas flowing past an input point for the take off points in the charging area and other gas, where the gas flowing past the input point is not conveyed to any take offpoint in the charging area without being commingled with the other gas; and

(ii) any of the average calorific values applicable on the gas day to any input point for the take off points in the charging area, where sub-paragraph (i)above does not apply.

(2) The daily calorific value of gas conveyed to any take off point not situated in a charging area in respect of a gas day shall be the take off point calorific value.

(3) In paragraph (1)(a) above, "the area calorific value" means:

(a) where there is one input point for the take off points in the charging area, the average calorific value applicable to that input point on the gas day; or

(b) where there is more than one input point for the take off points in the charging area, the calorific value given by the following formula, namely— where:

$$\frac{E - E^1}{V - V^1}$$

E = the sum of the relevant energy inputs at the input points;

E^1 = the sum of the relevant energy outputs at any output points for those take off points;

V = the sum of the relevant volume inputs at the input points;

V^1 = the sum of the relevant volume outputs at those output points,

and where:

"the relevant energy input", in relation to an input point, means the number of megajoules given by multiplying the average calorific value applicable to the input point on the gas day by that volume of gas in cubic metres recorded by the public gas transporter as flowing past the input point on that gas day;

"the relevant energy output", in relation to an output point, means the number of megajoules given by multiplying the average calorific value applicable to the output point on the gas day by that volume of gas in cubic metres so recorded as flowing past the output point on that gas day;

"the relevant volume input", in relation to an input point, means that volume of gas in cubic metres so recorded as flowing past the input point on the gas day;

"the relevant volume output", in relation to an output point, means that volume of gas in cubic metres so recorded as flowing past the output point on the gas day.

(4) In paragraph (2) above, "the take off point calorific value" means:

(a) where there is one input point for the take off point, the average calorific value applicable to the input point on the gas day; or

(b) where there is more than one input point for the take off point, the calorific value given by the following formula, namely:

$$\frac{E}{V}$$

where the symbols "E" and "V" have the same meanings as in paragraph (3)(b)above.

Appendix 9. DNV GL Technical Assurance Laboratory and Smart Meter Facility

The government's smart meter implementation programme is deploying smart meters in two phases. The initial foundation phase allows energy suppliers, networks, manufacturers, third parties and service providers to design, develop and test smart metering equipment and systems before the mass rollout which commenced in June 2016. All metering equipment, including auxiliary devices such as prepayment interfaces, hand held terminals, consumer access devices and networked load switches, must be compliant with technical specifications developed by DECC in collaboration with industry.

All metering equipment must be compliant with the Smart Meter Equipment Technical Specifications (SMETS). The specifications describe the minimum physical and functional requirements of gas and electricity meters, In Home Displays (IHDs), prepayment management devices, hand-held terminals and networked auxiliary electricity load switches. The architecture for smart meter implementation is shown in Figure A9.1.

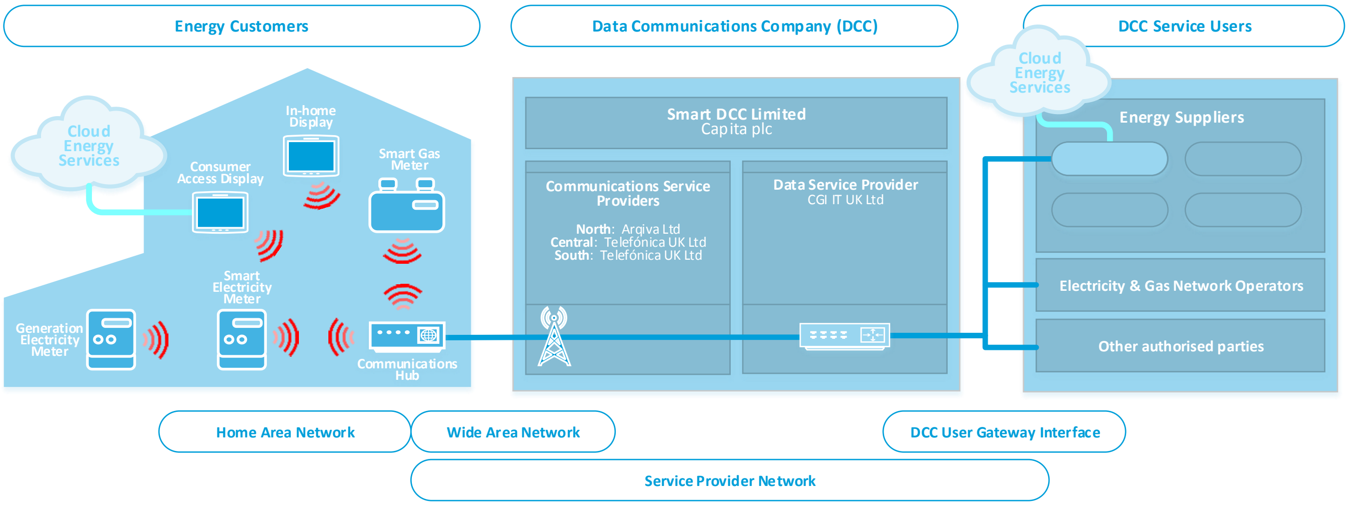


Figure A9.1: Smart meter implementation programme architecture

DNV GL has developed a comprehensive suite of tools to simulate and assure components of the smart metering infrastructure. The tools are compliant with the latest SMETS2 technical standards and are being used to test current smart electricity and gas meters, IHDs and other devices. The tools have been deployed in the DNV GL Smart Energy Labs in Peterborough and London, and by manufacturers and energy suppliers for in-house testing. In support of testing, DNV GL has developed a simulation of the DCC environment and emulators of the Communication Hub, IHDs and other support devices. The system is being developed further to support device interoperability and interchangeability testing for industry. This next step requires integration with the DCC.

The proposal for the Project is to demonstrate a proof of concept architecture to pilot the technology, systems and processes required to operate a solution using the DCC communication services following rollout of smart metering. The structure of the proposed pilot in work pack 3 is organised into three phases:

- Technology trial - lab-based emulation of the DCC infrastructure and stakeholders roles
- Field trial - extension of simulation environment to real gas meter and sensor network deployments
- DCC trial - integration of the DCC's communications services into the field trial architecture

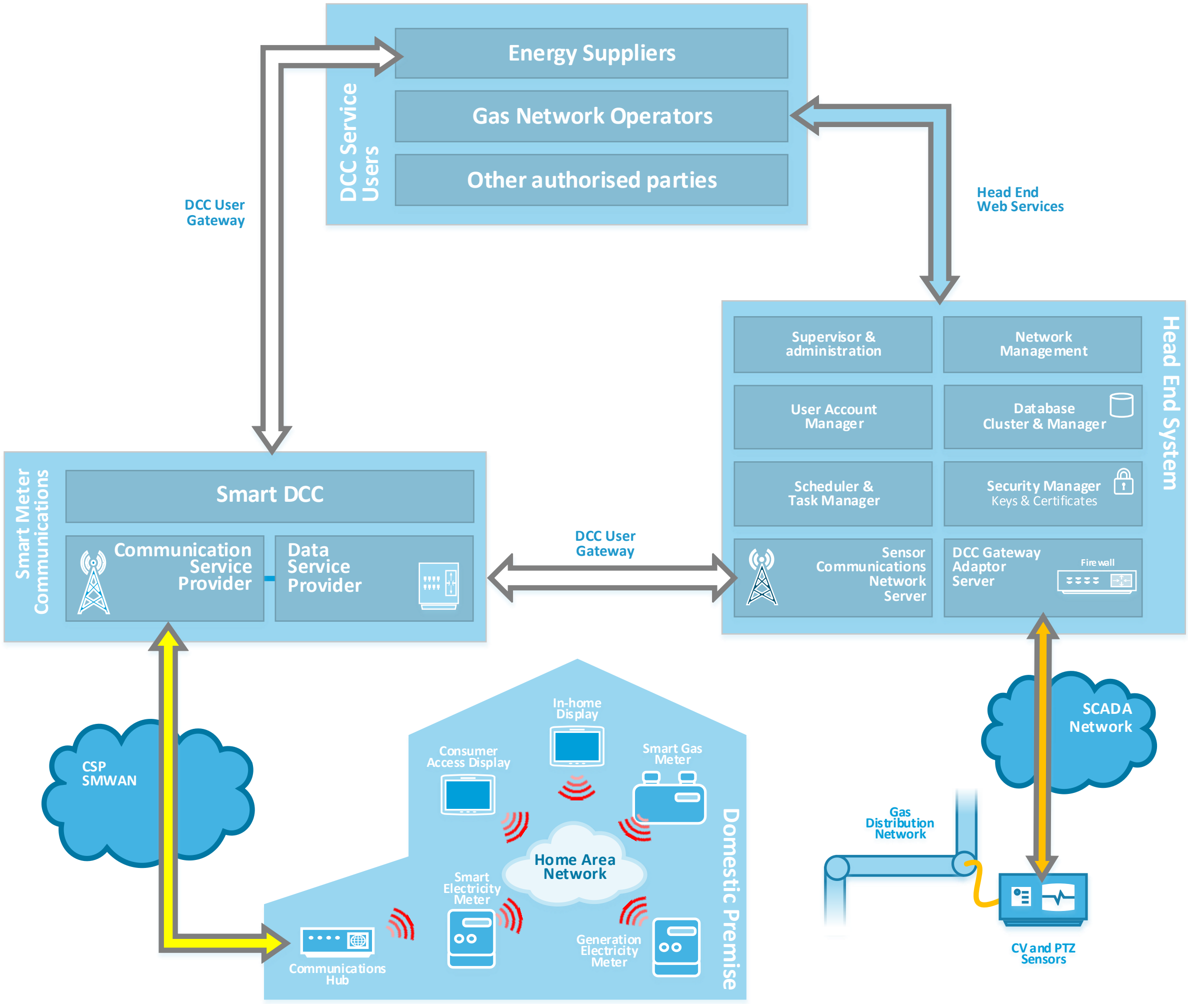


Figure A9.2: Architecture of near-live CV monitoring by smart meters

A phased approach provides a controlled environment in which to evaluate the technology, concepts and processes associated with each stakeholder required to operate the service allowing a measured transition from simulation to field deployed services.

A wide range of organisations, groups and bodies have an interest in smart metering including:

- DCC service users
- Retail suppliers
- Energy networks
- Registered data providers
- Meter asset managers
- Meter operators
- Energy services companies
- Manufacturers

- Data & Communications Company
- Data Services Provider
- Trusted Service Provider
- Communications service providers
- DECC
- Ofgem
- Consumer bodies
- Trade associations

A selection of stakeholders in smart meter technology and its roll out is summarised in Figure A9.3.

Figure A9.3: Selection of stakeholders in smart meter technology and roll-out

Appendix 10. Options for Measurements

The advantages and disadvantages of using propane addition for delivering the Project are summarised in the Table A10.1.

Propane Addition	Advantages	Issues
Yes	No CV capping or CV shrinkage associated directly with the project. No change to the existing commercial agreements at the selected field trial sites.	Does not reflect low carbon future as propane removal is a project objective. Need to measure a component of the gas as the CV of the propanated embedded gas will match natural gas. Modelling a gas component rather than CV; need confidence that the modelling of a zone of influence of the component is comparable with the CV modelling. Tracking a unique marker or gas component to model propanated gas through the network. Extend use of modelling technique to show the zone of gases of different compositions.
No	Simulate conditions similar to the lower carbon future whereby un-propanated gas enters the gas network without immediate downstream blending. Network modelling is validated by CV measurements.	Introduces CV capping and CV shrinkage which will need to be paid for within the transportation chain. Customers who receive the low CV gas but are billed on the FWACV will have higher gas bills during the field trials. Change to existing commercial agreements at selected field trial sites. Turning off propane would put the embedded entry point into alarm and potentially close the ROV.
Intermittent	No CV capping or shrinkage for most of the time.	The instrumentation will need to be installed for the no propane scenario, so will only provide readings periodically; costly for minimal information. Turning off propane would put the embedded entry point into alarm and potentially close the ROV.

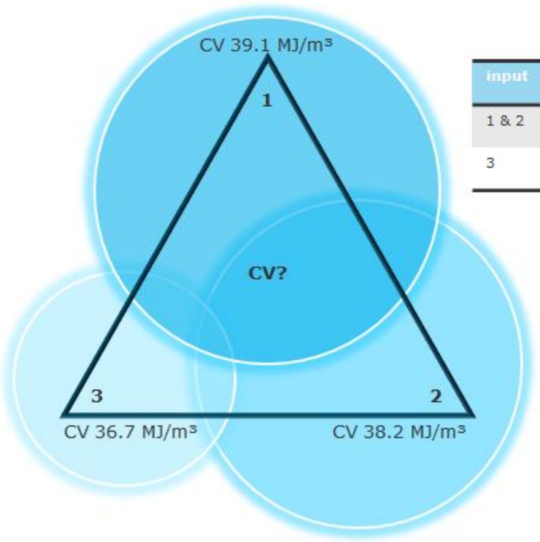
Table A10.1: Advantages and disadvantages of propane addition for field trials

If propane is to continue to be added to the biomethane, the measurements need to identify a unique property or component within the gas. Unique markers for biomethane could be:

- The propane supplied to biomethane sites is odorised with ethyl mercaptan whereas NTS gas and embedded gas supplies are odorised by a mixture of 20 mol% dimethyl sulphide (DMS) and 80 mol% tertiary butyl mercaptan (TBM).
- Biomethane entry points have a GS(M)R relaxation of 1 mol% for oxygen; the GS(M)R limit at NTS entry points is 0.1 mol% but the network entry agreements usually specify 0.001 mol% (see NTS Gas Quality Requirements in Appendix 7).
- Un-propanated biomethane has a low CV which is typically about 36.8 MJ/m^3 whereas NTS has a CV of about 39 MJ/m^3.
- A tracer injected into the gas.

Appendix 11. Quantification of the Number of consumers impacted – details

To understand and quantify what this might mean to a customer in different CV zones a simplified network diagram has been used as shown below.



input	Description
1 & 2	Indicative of NTS Offtake
3	Indicative of biomethane offtake

Figure A11.1: Three gases with different CVs supplied to an LDZ. The diameter of the circles indicates the volume in the network and the overlap the extent to which consumers will receive each type of gas

The following analysis is based on a single domestic consumer in each of the zones with the same energy use of 13,500 kWh in each of the 3 billing examples, A, B & C. Note that the metered volume of gas will differ because of the different gas CV and hence energy content as shown in the table below. Zone 3a is a propanated biomethane and the CV is increased sufficiently to prevent the capping of the network. Zone 3b is un-propanated biomethane.

Input zone	Note	1	2	3a	3b
CV delivered in MJ/m^3	1	39.1	38.2	38.0	36.7
Energy demand in kWh	2	13500	13500	13500	13500
Gas (COTE) Regulations correction factor	3	1.02264	1.02264	1.02264	1.02264
Energy demand in kWh with correction factor applied	4	13806	13806	13806	13806
Energy demand in MJ	5	49700	49700	49700	49700
Metered volume in m^3 based on input zone delivered CV	6	1271	1301	1307	1354
British Gas Standard tariff p/kWh	7	£0.0486	£0.0486	£0.0486	£0.0486

Table A11.1: Consumer gas volumes required to meet AQ of 13,500 kWh

Note

1 The CV of the gas measured at the input point

2 Mean annual consumption per household taken from https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/437093/National_Energy_Efficiency_Data-Framework__NEED__Main_Report.pdf

3 Gas (Calculation of Thermal Energy) Regulations correction factor

4 Energy demand x 1.022664

5 To convert kWh to MJ, multiply by 3.6

6 Metered volume = energy demand / CV

7 British Gas Standard tariff from http://www.britishgas.co.uk/products-and-services/gas-and-electricity/our-energy-tariffs/standard.html

Currently consumer bills are generated using the FWACV methodology; this was developed to try and ensure that the billing system was simple to implement and that the billed energy was close to the delivered energy. The system was developed at a time when the gas delivered into the GDNs was nearly all supplied through NTS offtakes. As more gas supplies are delivered into the GDNs from embedded sources, the mix of gas and the variation in CV means that the gas quality in a GDN is no longer managed solely by the NTS.A plot of the relationship between CV and volume to give the fixed energy requirement is shown in Figure A11.2.

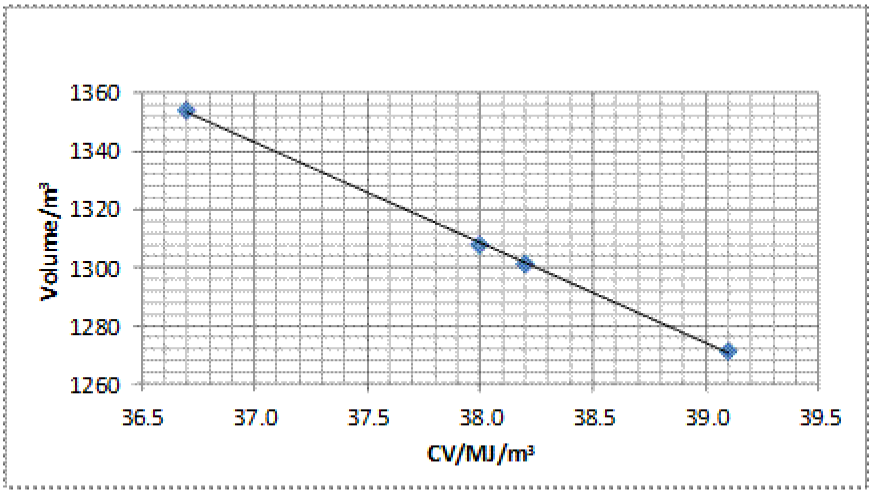


Figure A11.2: Plot showing the relationship between CV and volume for a fixed energy requirement

For a decrease in CV of 1 MJ/m^3 there is an increase in the metered volume of 34 m^3 to deliver a fixed energy requirement. This relationship is fundamental to understanding the reasons for the variation in consumer bills.

The CV of the gas delivered to consumers is dependent on the range of the CVs delivered to the LDZ and their location relative to the supply inputs. If consumers are close to a high CV entry point they are likely to receive high CV gas, if close to a low CV supply then they will receive a lower CV gas. However consumers are not billed on the CV delivered to their property but on a billing CV based on all gas being delivered to the LDZ – the FWACV. There are a number of possible ways to allocate a billed CV to address the impact of lower CV entry gases. The three examples below, A, B and C, consider the impact on a consumer's bill of different billing CV approaches; see Appendix 11 for further detail on the calculations for each example.

Example A – "The As-Is option" - The consumer's bill is calculated using the FWACV value assuming that the example biomethane input is propanated to prevent the CV cap being invoked. In this example, the consumer in zone 1 receives high CV gas (39.1 MJ/m^3) and therefore needs less volume to meet the fixed energy requirements. The consumer in zone 1 is billed on a lower CV than that which is received (38.65 MJ/m^3), so pays less compared to the customer in zone 3 who is actually receiving lower CV gas (38.0 MJ/m^3), and consequentially has a higher metered volume of gas to meet the energy requirement; the variation amounts to £19.20. The results are shown in Table A11.2.

Input Zone	1	2	3a*
CV (MJ/m^3)	39.1	38.2	38.0
Flow (mcm)	100	100	1
FWACV (MJ/m^3)	38.65		
Billing CV (MJ/m^3)	38.65		

Table A11.2: CV levels and flow rates where the consumer is billed on a FWACV (example A)

Notes:

1. FWACV/(MJ/m^3) = (39.1 x 100) + (38.2 x 100) + (38.0 x 1) / 201
2. Billing CV = FWACV
3. Input zone 3a* is propanated biomethane

The impact on the consumer bills in each of the three zones is detailed in Table A11.3.

Example A "as is"	Zone 1	Zone 2	Zone 3a	Zone 3a- Zone 1
Billing CV = FWACV in MJ/m^3	38.65	38.65	38.65	
Total energy in kWh on bill	13646.75	13968.27	14041.79	
Consumer bill	£663.23	£678.86	£682.43	£19.20

Table A11.:3 Variation in consumer bills based on FWACV (example A)

In this example, the consumer in zone 1 receives high CV gas (39.1 MJ/m^3) and therefore needs less volume to meet the fixed energy requirements. The zone 1 consumer is billed on a lower CV (38.65 MJ/m^3), so pays less compared to the customer in zone 3 who is actually receiving lower CV gas (38.0 MJ/m^3), and, consequentially, has a higher metered volume of gas to meet the energy requirement; the variation in terms of money amounts to £19.20.

Example B – "No propanation – CV cap invoked" - Example B looks at the LDZ FWACV being capped as the low value CV gas has not been propanated. This example shows how a very small volume of low CV gas entering the LDZ can invoke the CV cap and the impact this has on the consumer's bill. Again the consumer in zone 1 receives high CV gas but is billed on a much lower CV because of the CV cap. The zone 1 consumer bill is significantly lower than the consumer in zones 2 and 3; a variation of £42.31. The impact on the consumer's bill is shown in Table A11.4.

Input Zone	1	2	3b*
CV (MJ/m3)	39.1	38.2	36.7
Flow (mcm)	100	100	1
FWACV (MJ/m^3)	38.6		
Billing CV (MJ/m^3)	37.7		

Table A11.4: CVs and flow rates for the consumer is billed on a capped FWACV (example B)

Notes:

1. FWACV/(MJ/m^3) = (39.1 x 100) + (38.2 x 100) + (36.7 x 1) / 201
2. Billing CV = 1 MJ higher than lowest input CV
3. Input zone 3b* is biomethane not propanated

The impact on consumer bills in each of the 3 zones is shown in Table A11.5.

Example B – with 1MJ/m^{3}CV cap	Zone 1	Zone 2	Zone 3	Zone 3b- Zone 1
Billing CV with cap invoked in MJ/m^3	37.7	37.7	37.7	
Total energy in kWh on bill	13311.32	13624.94	14181.82	
Consumer bill	£646.93	£662.17	£689.24	£42.31

Table A11.5: Variation in consumer bills based on a capped FWACV (example B)

In this example, again the consumer in zone 1 receives high CV gas and is billed on a much lower CV because of the CV cap. The zone 1 consumer bill is significantly lower than the consumer in zones 2 and 3; a variation of £42.31.

Example C – The "billed on delivered CV" option - In order for all consumers to pay the "correct" amount for the energy that they use, it would be necessary to be able to determine the CV of the gas being delivered at the point of use. Example C examines the impact of using the delivered CV for billing purposes as shown in Table A11.6.

Input Zone	1	2	3b*
CV (MJ/m^3)	39.1	38.2	36.7
Flow (mcm)	100	100	1
FWACV (MJ/m^3)	38.6		
Billing CV (MJ/m^3)	As input value		

Table A11.6: CV and flow rates where the consumer is billed on the delivered CV (example C).

The impact on the consumer bills in each of the 3 zones is shown in Table A11.7.

Example C – delivered CV	Zone 1	Zone 2	Zone 3	
Billing CV delivered CV	39.1	38.2	36.7	
Total energy in kWh on bill	13805.64	13805.64	13805.64	
Consumer Bill	£670.95	£670.95	£670.95	£0

Table A11.7: Variation in consumer bills based on a delivered CV (example C).

As all the consumers are being billed based on the CV of the gas received, the bills are all the same.

Example comparison

The impact on the bills for these three examples is combined in the Table A11.8.

Input Zone	1	2	3a	3b
Received CV in MJ/m^3	39.10	38.20	38.00	36.70
FWACV in MJ/m^3	38.65	38.65	38.65	
Capped CV in MJ/m^3	37.70	37.70		37.70
Scenario A - FWACV bill	£663.23	£678.86	£682.43	
Scenario B - low capped CV bill	£646.93	£662.17		£689.24
Scenario C - delivered CV bill	£670.95	£670.95		£670.95
FWACV to low capped CV bill change	-£16.30	-£16.69	£6.81	
FWACV to delivered CV bill change	£7.72	-£7.90	-£11.48	

Table A11.8: Comparison of consumer bills for each example

The last 2 rows of the table show the impact of a change in the billing regime; from FWACV to the capped FWACV, where a consumer in zone 1 or 2 would pay over £16 less and a consumer in zone 3 would pay nearly £7 more. Where the billing methodology changes from FWACV to the CV that is delivered, a consumer in zone 1 would pay £7.72 more and consumer in zone 2 and 3 would pay between £7.90 and £11.48 less.

Comparison of consumer bills for each example

These figures have been extrapolated to show the financial impact for the supply to a million consumers in the Table A11.9.

Zone	1	2	3	Total
Number of consumers	500,000	500,000	5,000	
FWACV to low capped bill	-£8,150,976	-£8,343,015	£34,026	-£16,459,966
FWACV to delivered bill	£3,860,989	-£3,951,954	-£57,384	-£148,349

Table A11.9: Total billing differences based on 1,000,000 domestic consumers

Note * 1 million domestic consumers used. The approximate total MPRN count for the following LDZs is EA 1.8 million, EM 2.2 million, NT 2.2 million, NW 2.7 million and WM 1.9 million.

There is a significant difference in the consumer's bills. These examples were set up based on the assumption that a consumer in each zone needs the same energy input so, in an ideal situation, should be paying the same billed amount for the gas used. Although the FWACV is a reasonable way of dealing with small variations in CV in an LDZ this is clearly not the case when a significant range of CVs are introduced into a gas supply system. In the example above, a move from FWACV to a capped CV the 'under payment' of £16.5 million calculated at an LDZ level would need to be accounted for somewhere in the overall consumer billing process; potentially through increased CV Shrinkage.

Appendix 12. Carbon Dioxide Emissions

Natural gas is, typically, about 90 mol% methane. One molecule of methane contains one carbon atom. When methane is burnt in the presence of oxygen, one molecule of carbon dioxide is produced according to the following equation:

$CH_4 + 2O_2 = CO_2 + 2H_2O$ CV = 37.78 MJ/m^3 CEF = 49.36 t-CO_2/TJ

The calorific value and the carbon dioxide emission factor (CEF) of the simplest hydrocarbon, methane, provide a baseline for the higher hydrocarbons which have increasing carbon to hydrogen ratios. For example, one molecule of propane contains three carbon atoms and when burnt in the presence of oxygen, three molecules of carbon dioxide are produced:

$C_3H_8 + 5O_2 = 3CO_2 + 4H_2O$ CV = 95.65 MJ/m^3 59.4 t-CO_2/TJ

The calorific value of propane is about 15% less than three times the value of methane and the quantity of carbon dioxide produced is 20% greater for every TJ of energy produced.

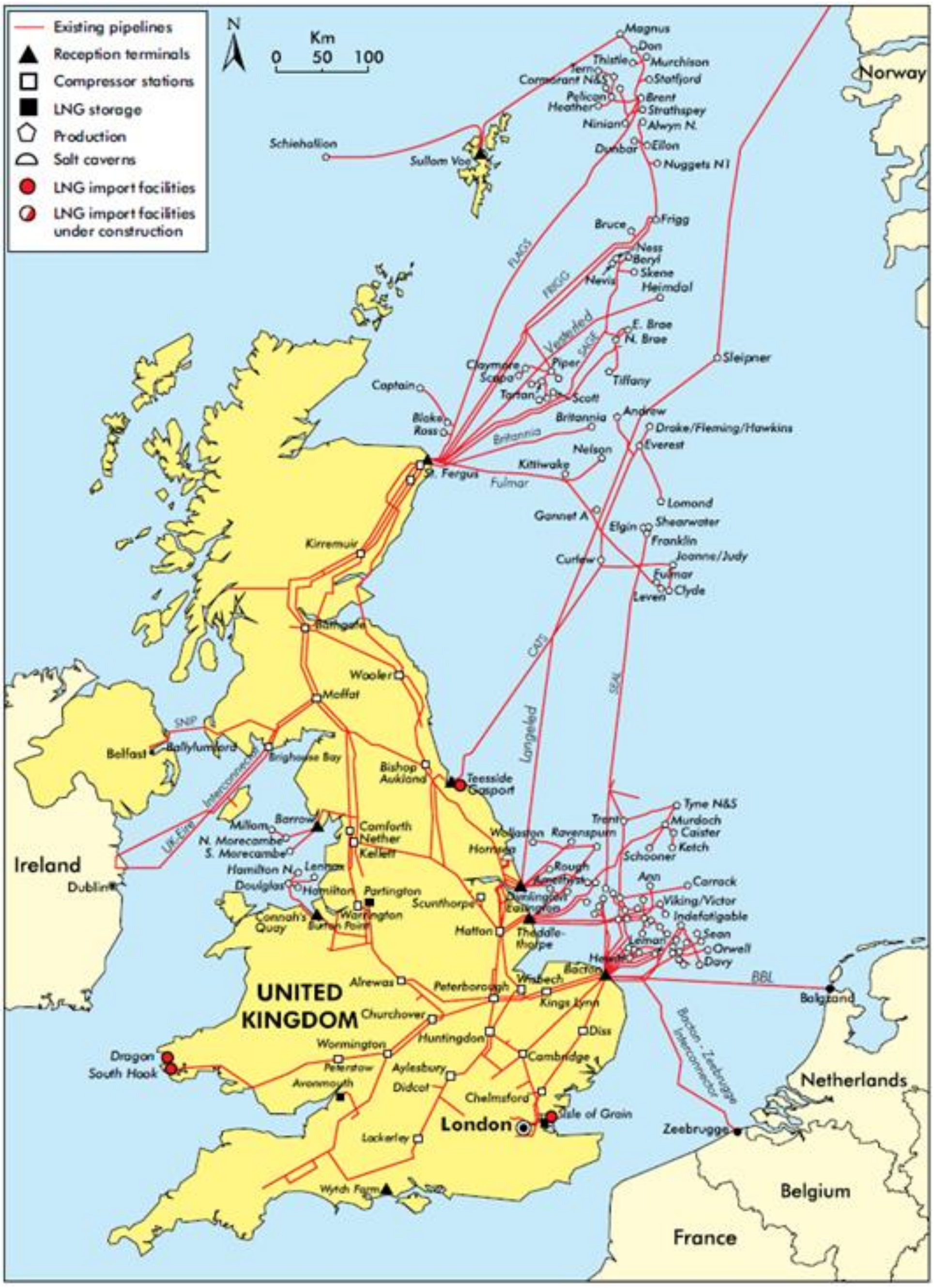
In terms of carbon dioxide production per unit of energy produced, methane is a more environmentally friendly fuel than propane. This is a further reason to review the use of propane for enriching low CV gases.

Appendix 13. Impact of Future Gas Supplies

Appendix 13. Impact of Future Gas Supplies

<u>The future of natural gas</u>

The UK gas industry has a 200 year history which has seen the switch to natural gas, and the development of national and gas transmission and distribution networks. The industry has been privatised, and has seen the introduction of international sources of gas via pipelines and in shipped in liquefied form from around the world. The National Gas Transmission System, as of 2015, showing existing pipelines, sources of domestic production, reception terminals and LNG import facilities is shown in Figure A13.1.



<u>Figure A13.1: The National Gas Transmission System 2015</u> *(from DUKES 2016)*

Natural gas is hugely important within the GB energy mix, and will continue to so be over the next decades, with one extremely crucial role of natural gas being to provide the energy for families to heat their homes, particularly during winter.

As the British gas industry changes in the future in response to a host of challenges, not least the declining indigenous supply from the UK Continental Shelf (UKCS) and carbon emissions targets / decarbonisation, it is vital that the Billing Methodology for gas consumption by GB consumers remains fit for purpose with consumers being billed closer to their actual energy consumed.

Statutory decarbonisation is a measure that has been included in the Energy Act and targets have been set in domestic legislation. The Project, by facilitating the acceptance of low carbon gases, contributes to the meeting of decarbonisation targets.

Impact of Future Gas Supplies

Production of natural gas from the UK Continental Shelf (UKCS) came off plateau from 2000. Since then, the UK dependency on gas imports has ramped up rapidly, though the UK continued to export natural gas to the continent. Figure A.13.2 shows the annual supply pattern of natural gas for the UK for the period 2000-2015, in billion cubic metres (bcm) per year by source, as collated by National Grid. Also shown in Figure A13.2 is the import dependency as a percentage of the total gas supply. Since 2004, UK imports of natural gas have exceeded its exports and the UK has been a net importer of gas; initially through pipelines and then through a combination of pipelines and LNG.

Figure A13.3 shows the decline in indigenous production from the UKCS (n.b. some indigenous production is exported to Europe) together with the evolution of the UK from being a net exporter to net importer of natural gas.

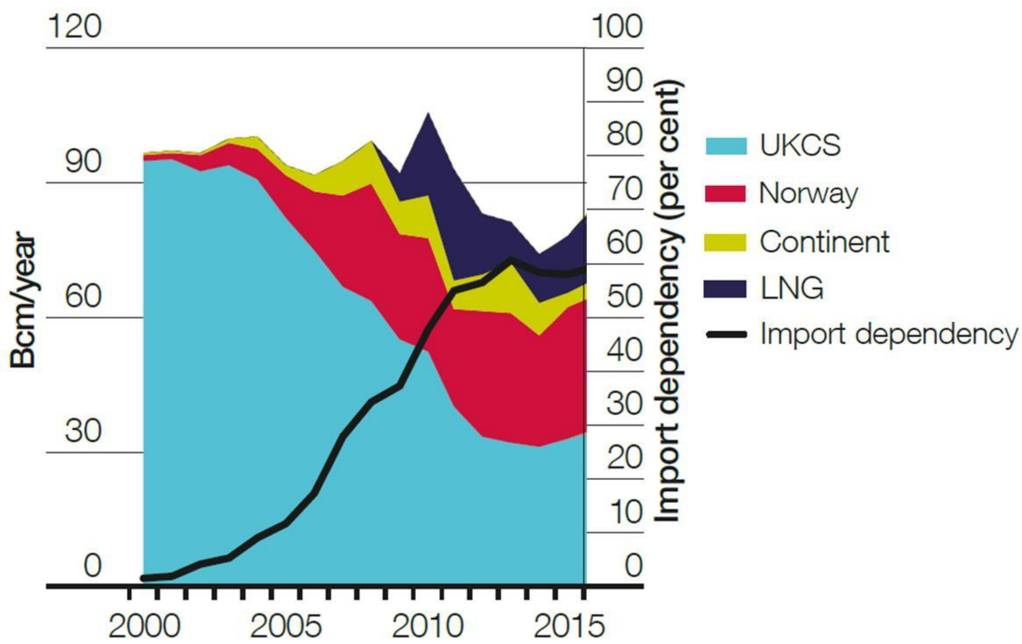


Figure A13.2: Annual natural gas supply pattern to the UK 2000 – 2015 *(source: National Grid)*

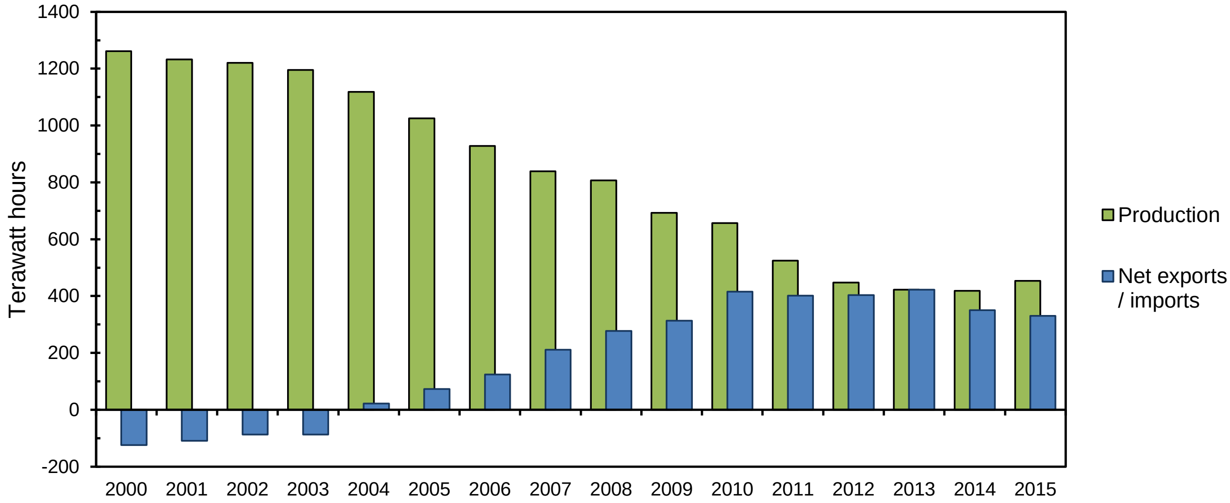


__Figure A13.3: UK natural gas production & net exports/imports 2000 – 2015__ (Source: DUKES)

National Grid has determined from information provided by producers, in combination with Oil and Gas UK, that UKCS production, which increased modestly from 2014 to 2015 following a decade of decline, will continue to modestly increase in the short term (3-4 years) before once more declining. Gas supplied by pipeline from Norway will continue to provide a major proportion of UK gas demand beyond 2040 whereas supply by pipeline from continental Europe and imports by LNG are subject to much greater uncertainty but will, nevertheless, continue to be important elements in the mix of UK supply.

The current billing methodology that is based on the FWACV was devised and implemented when traditional indigenous UK production dominated gas supply. The billing methodology has continued to be fit for purpose as the UK began to import natural gas through the small number of large volume pipeline connections and three world-scale onshore LNG terminals.

Consumers are billed on energy content (the product of gas volume and CV of the gas) so it is important that consumer bills accurately reflect the gas quality that they receive.

Gas supply is evolving in the UK with increasing numbers of new sources of gas entering the network. Furthermore, in order to meet the 2020 renewable energy target, there is growing interest in the production of biomethane, bio-SNG and hydrogen for injecting directly into a gas network. The FWACV billing regime ceases to be fit-for-purpose where there are diverse gas supplies with varying CV. Very small volumes of gas have a disproportionate influence and can "cancel out" very large volumes. The FWACV regime has served the UK well is increasingly, and will continue to, create the undesirable situation where larger numbers of consumers are billed incorrectly against their actual energy usage and is creating cross-subsidies.

In addition to being a net importer of natural gas the UK also exports gas by pipeline to continental Europe and, commencing in 2015, the Isle of Grain now offers its customers an LNG reloading and re-export service. The UK's gas trade in terms of imports and exports in 2015 is summarised in Table A13.1 together with the corresponding values for 2014.

The majority of the UK gas consumption is from gas sourced from the UKCS, the pipeline connections to the UK and via the three LNG terminals where relatively large volumes of gas can enter the transmission and distribution network in a small number of entry points. New non-conventional sources of gas (including biogas, hydrogen and, in the future, shale) will increasing be introduced into the network in larger numbers of connections and, most significantly, anywhere in the system. The new connections of non-conventional gas impact both the current billing regime which had been developed and was fit for purpose when there was a small number of large volume supplies. There is a strong business case, as is outlined in this section, for addressing the billing methodology by developing, trialling and proposing a future billing methodology that more appropriately reflects the reality of the move to having an integrated transmission and distribution system that will feature multiple new non-conventional gas inputs at any point within the system.

FWACV was fit for purpose but recent reports from KPMG, H21, HyDeploy, Climate Change Committee, etc., will require a new billing methodology.

To operate under other, non-gas, scenarios requires massive investment by domestic customers with long pay back times.

Source	2014 Volume/bcm	2015 Volume/bcm
Pipeline imports	29.4	29.0
LNG imports	10.7	12.8
Total imports	**40.1**	**41.8**
Pipeline exports	10.0	13.4
LNG exports	0.0	0.3
Total exports	**10.0**	**13.7**
Net natural gas imports	30.1	28.1

Table A13.1: UK natural gas imports and exports 2014 and 2015

The ability to use imported gases and new non-conventional gases is maintained through compliance with GS(M)R. The GS(M)R apply to the conveyance of natural gas through pipes to consumers and use a Wobbe Index (WI) based interchangeability approach to ensure that gas conveyed will burn safely and efficiently.

A summary of the current and future gas supplies that may enter the GB gas transportation system are described below.

Pipeline sources

The pipeline interconnectors from each of Norway, Belgium and the Netherlands to the UK are well established and supply gas to meet the current GS(M)R gas quality specifications. The gas from Norway through Langeled arrives at the Easington terminal. Gas from Norway will normally meet the required UK gas sales specification. Some properties of the gas, however, may be outside UK requirements; namely the WI and Incomplete Combustion Factor. Thus it is necessary to have a backup system that will inject nitrogen in the future when offshore blending might not be available. The Easington terminal and gas supply is designed for a 50-year lifetime. The interconnectors to Belgium and the Netherlands are similar and operated to ensure gas quality compliance, but with new gas supplies to mainland Europe and a decline in the availability of Groningen gas, there may be impacts on the supplied gas quality in the future. At the present time, there are no new "UK-to-Europe" pipeline interconnectors planned and the current terminal infrastructure is able to meet the gas quality demands.

LNG

The composition of liquefied natural gas (LNG) varies depending on the source and the processing during the liquefaction process. Table A13.2 shows typical compositions and higher heating values of a number of a number of world LNGs as published by GIIGNL.

Origin	N2	C1	C2	C3	C4+	HHV MJ/m^3 (0°C)	HHV MJ/m^3 (15°C)
Australia - NWS	0.0	87.3	8.3	3.3	1.0	45.3	42.9
Brunei	0.0	90.1	5.3	3.0	1.5	44.7	42.4
Indonesia - Badak	0.0	90.1	5.5	3.0	1.4	44.6	42.3
Australia - Darwin	0.1	87.6	10.0	2.0	0.3	44.4	42.1
Oman	0.2	90.7	5.8	2.1	1.2	44.0	41.7
Malaysia	0.1	91.7	4.6	2.6	0.9	43.7	41.4
Algeria - Arzew	0.7	88.9	8.4	1.6	0.4	43.5	41.2
Qatar	0.3	90.9	6.4	1.7	0.7	43.4	41.1
Nigeria	0.0	91.7	5.5	2.2	0.6	43.4	41.1
Russia - Sakhalin	0.1	92.5	4.5	2.0	1.0	43.3	41.0
Indonesia - Arun	0.1	91.9	5.7	1.6	0.8	43.3	41.0
Algeria - Bethioua	0.6	89.6	8.2	1.3	0.3	43.2	41.0
Peru	0.6	89.1	10.3	0.1	0.0	42.9	40.7
Norway	0.5	92.0	5.8	1.3	0.5	42.7	40.5
Algeria - Skikda	0.6	91.4	7.4	0.6	0.1	42.3	40.1
Yemen	0.0	93.2	5.9	0.8	0.1	42.3	40.1
Equatorial	0.0	93.4	6.5	0.1	0.0	42.0	39.8
Trinidad	0.0	96.8	2.8	0.4	0.1	41.1	39.0
Indonesia - Tangguh	0.1	96.9	2.4	0.4	0.2	41.0	38.9
USA - Alaska	0.2	99.7	0.1	0.0	0.0	39.9	37.8

Table A13.2: Average LNG gas composition *(Source: GIIGNL, 2015)*

Figure A13.4 shows the import sources of natural gas and respective quantities on an annual basis by both pipelines and LNG per annum for the period 2000 – 2014.

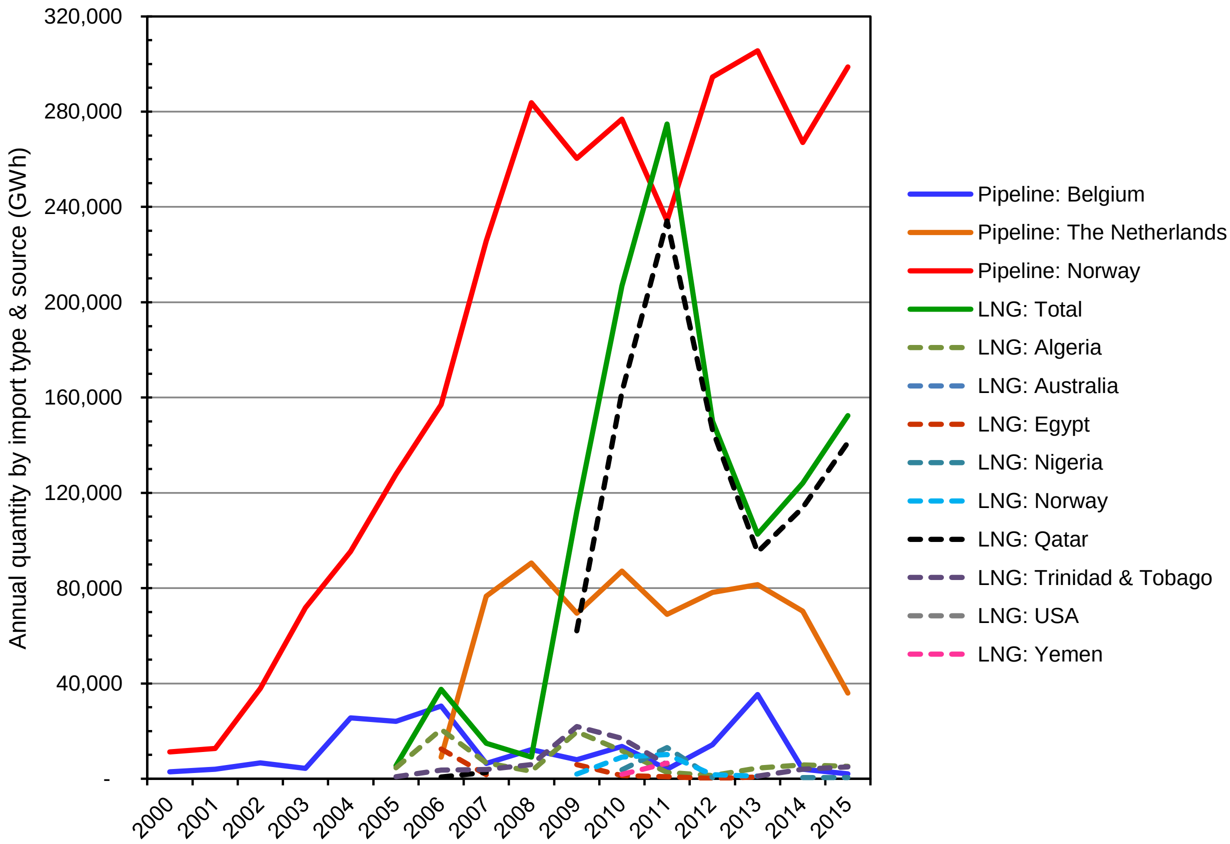


Figure A13.4: Natural gas imports into the UK by source and quantity (GWh/annum) *(DUKES)*

The LNG import facilities in the UK are located at the Isle of Grain, and Milford Haven - Dragon LNG and South Hook LNG. These import facilities have taken LNG shipments from a number of sources but over the last six years the main source has been Qatar as shown in Figure A13.4. LNG from Qatar is relatively "rich" with high ethane content and cannot meet the GS(M)R requirements directly. Nitrogen ballasting is used to lower the WI of Qatari LNG for which ~2% (by volume) nitrogen is required.

Future LNG sources may impact on the operation of the import terminals, and the degree of nitrogen ballasting may change. In addition, LNG from USA shale gas production may become available but this 'lean' having a high methane content and although it will be compliant with GS(M)R, it may not have a CV close to pipeline gas.

Biomethane

Biomethane (BM) produced from anaerobic digestion (AD) of biomass is an emerging technology. AD plant location and size are dependent on resource availability, and the potential market or outlet for the energy produced. Typical plant sizes for BM production are in the range 500 – 2000 m^3/h. Previous studies have shown that the BM potential may be up to about 10% of the total gas usage in GB, but the early difficulties in establishing plant may limit the growth rate and it is anticipated that BM flows will be relatively low (probably no more than 5% of the total GB gas usage)for the foreseeable future.

BM gas quality meets the requirements of the GS(M)R, but to ensure that the injected gas has a calorific value close to that of the natural gas in the network, significant amounts of propane or LPG are required to be added. In the GB network, the typical gross calorific value is 39.0–39.5 MJ/m^3 while that for BM is lower at around 37.7 MJ/m^3, so about 4% by volume of propane is required to enrich the BM.

Biomass gasification is a process that converts solid biomass into a combustible gas (bio-SNG). The composition of bio-SNG depends on the technology and material being gasified. There are several gasification process designs, including fixed bed, fluidised bed, multi-stage, indirect and plasma technology. biomethane is produced from bio-SNG by a process know as 'methanation' using advanced catalytic and chemical processing techniques after first clean-up and filtering of the bio-SNG. Methanation can produce pipeline quality BM but this too requires propane enrichment to meet the CV requirements of the networks.

Production of Bio SNG has been piloted at the Gussing plant in Austria and a demonstration plant at GobiGas has been in operation since December 2014. A 7-year evaluation period is now planned and a 100 MWth phase II demonstration scale plant is proposed. Commercial operation at large scale is thus at least 5-10 years away.

Hydrogen

Hydrogen is set to become an important future energy carrier as it can significantly improve the security of energy supply and reduce/avoid emissions of greenhouse gases. There are numerous potential sources of H_2 including gasification but the one that is receiving significant attention at the moment is the "Power-to-Gas" approach where surplus renewable electricity is used to generate H_2 by electrolysis and then this H_2 can be added to the natural gas grid. The combustion of natural gas with added H_2 emits less carbon dioxide per energy unit than the combustion of pure natural gas, as the combustion of H_2 is "carbon free". High levels of H_2, however, increase the flame speed and this impacts on the usability in current appliances. Thus H_2 content is limited to small amounts at present.

GS(M)R limits the H_2 content to 0.1 mol%, but previous studies in the UK demonstrated that 10% would be acceptable to most appliances. There is much discussion around Europe, at present, with the aim of establishing a suitable H_2 limit and one important factor is the limit for compressed gas cylinders used in NGVs. Here a maximum of 2% is allowed but new domestic appliances could potentially tolerate at least 5% and possibly up to 10%.

Further research on the usability of H_2 enriched natural gases as fuel for a wide range of combustion equipment is required to develop sufficient information on which to decide a new, realistic limit to be used in GS(M)R.

If H_2 is added to natural gas then this has an impact on the CV and WI as well as the flame speed. Also, measurement of the H_2 content may be difficult using traditional gas chromatography equipment. Notably H_2 is not measured by the current Ofgem approved GCs used for determining CV for customer billing. None of these issues is seen as a "show-stopper" but further work is needed to ensure that hydrogen addition to natural gas meets the potential benefits with regard to decarbonisation and end-use.

In parallel to the potential addition of H_2 to the natural gas pipeline network, there are proposals to set up separate H_2 networks that will be operated independently and use the hydrogen gas in fuel cells and vehicles.

Shale Gas

Shale gas developments in the UK are struggling due to rejection of the recent planning proposals. Much of the public and political discourse surrounding shale gas has focussed on concerns over safety, particularly in relation to fracking (hydraulic fracturing). With the current status of shale gas exploration in the UK, it is unlikely that production will be at anything other than exploratory levels until the early 2020s, unless there is a significant level of UK government support.

The current information on shale gas chemical composition in the UK is scant, with only limited information available from the British Geological Survey and DECC which state that "in most UK (shale) gas fields there are insufficient gas composition data" and "The gas composition was reported to be high in nitrogen and in ethane, though this may be incorrect".

Shale gas, along with other unconventional gases could be transported in the natural gas transmission and distribution pipeline networks as long as it is shown to comply with GS(M)R and if the CV meets the required value.

Variability of Natural Gas Supplies

The range of potential gas sources and gas qualities is shown in Figure A12.5 on a traditional Dutton Wobbe Index based gas interchangeability diagram and including information available on US shale gases to highlight the potential variability in gas quality and composition. Here the different gases are shown as coloured ranges together with their average CV. The USA shale gases have been included for comparison but it must be highlighted that no UK shale gas quality data has been determined. The unballasted LNG sources have high WI and CV, whereas the unpropanated biomethane has a relatively low CV.

This type of diagram cannot be used for gases containing additional hydrogen. It also should be noted that gases with greater than 20% non-methane (equivalent propane/nitrogen) have not been evident.

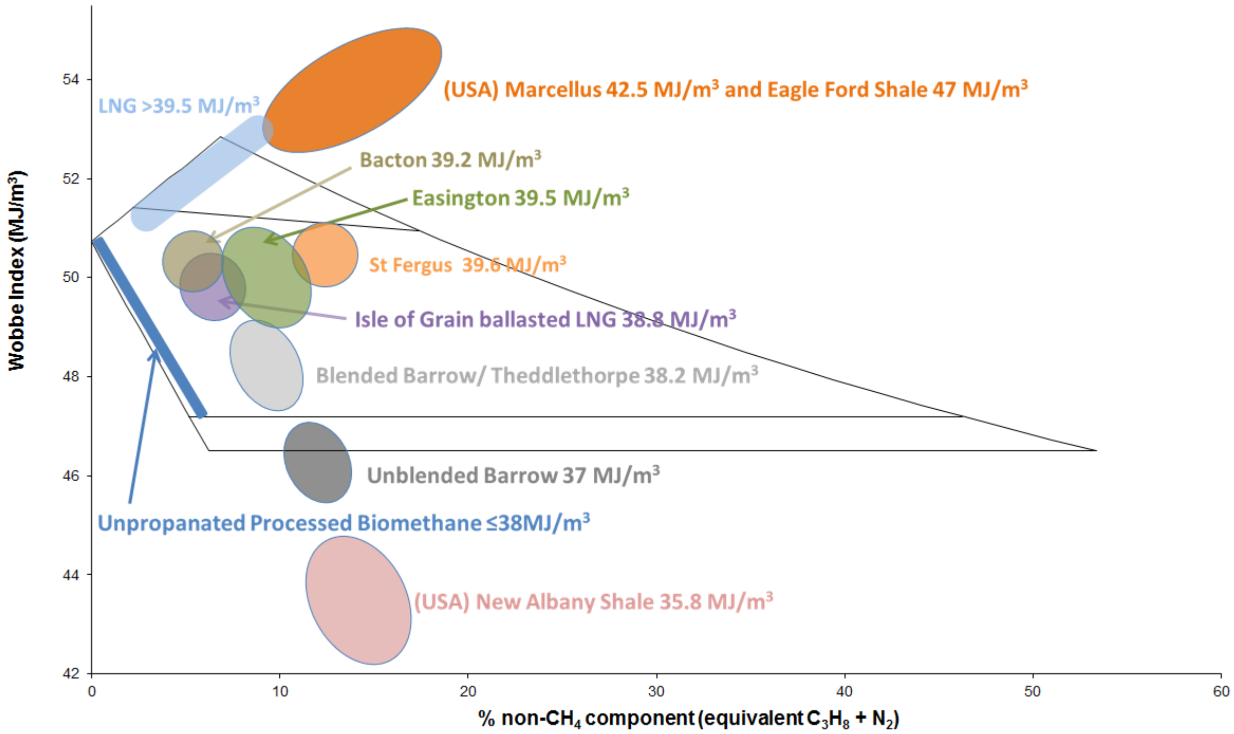


Figure A13.5: Gas interchangeability diagram for a range of gas sources

In addition to the WI based interchangeability diagram, ranges of methane, ethane and propane are shown in Figures A13.6, A13.7 and A13.8, respectively. Also, the required operational range for each component measured using an Ofgem approved GC used for determining CV for customer billing is included to show that the gas qualities are within the approved analytical range.

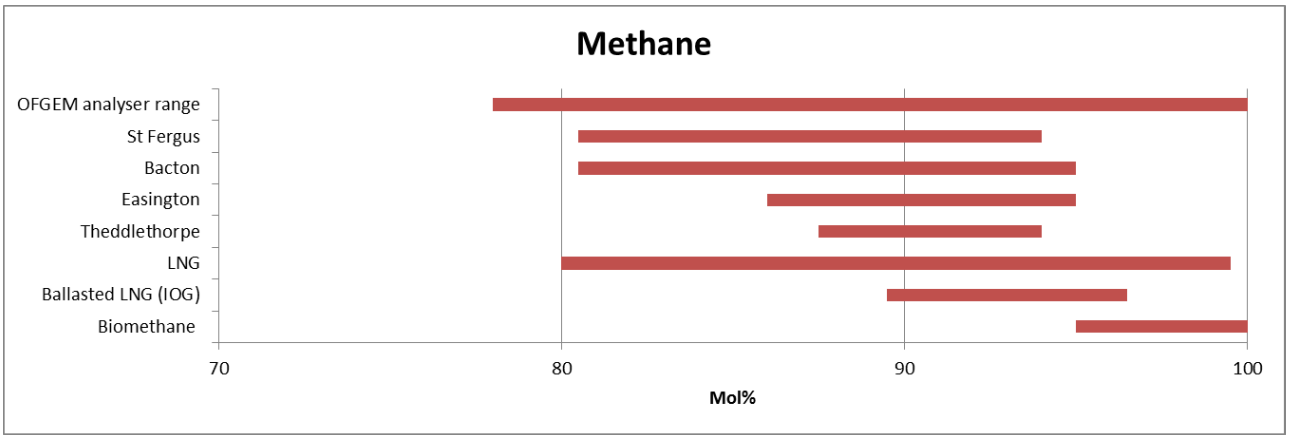


Figure A13.6: Methane content as a function of the gas source

The variation in methane content is typically between 80 – 100% depending on the source. Biomethane can have high methane content but does not contain higher hydrocarbon components which results in a low CV compared to natural gases. Hence propane is required to meet the target CV.

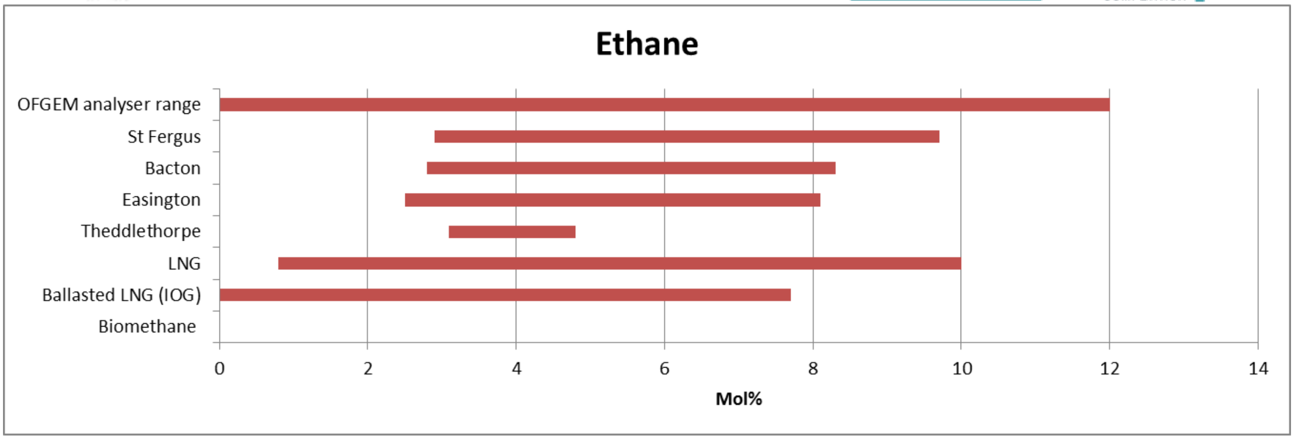


Figure A13.7: Ethane content as a function of the gas source

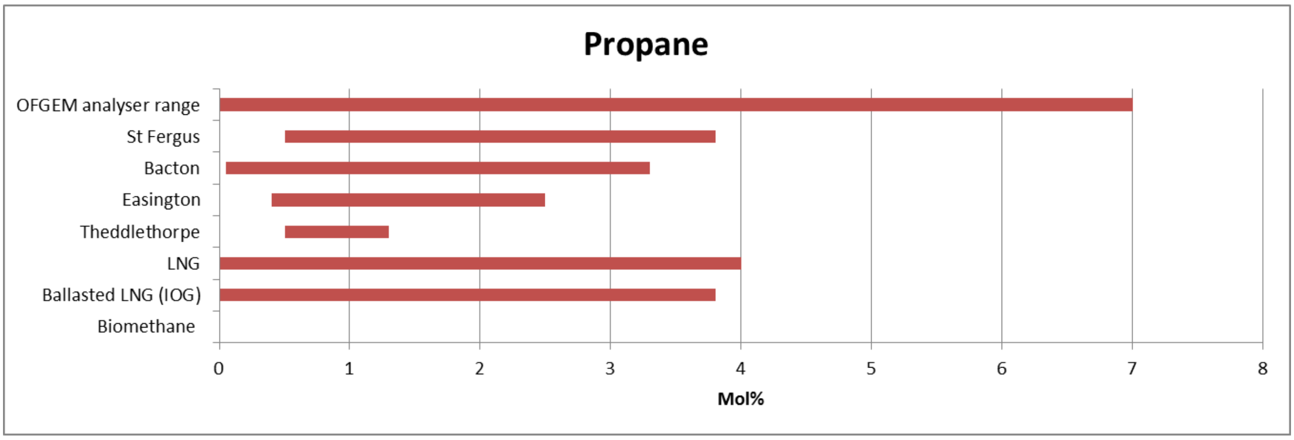


Figure A13.8: Propane content as a function of the gas source

Ethane and propane content vary with the gas source, with St Fergus gas having relatively high content compared to Theddlethorpe.

Figures A13.6-8 highlight the variability in gas quality and also the link to the gas interchangeability diagram demonstrates the robust approach to ensuring gas safe use.

Appendix 14. Summary of Current and Bidding NIC Projects

Network	Date	Project Title	Description	New gas quality initiative
NGGDL	2013	BioSNG Demonstration Plant	Developing a commercially viable facility that can process waste, covert it to synthetic biogas and distribute it through the existing gas network to consumers.	Yes – low CV
NGGDL	2015	Commercial BioSNG Demonstration Plant	Developing a commercially viable facility that can process waste, covert it to synthetic biogas and distribute it through the existing gas network to consumers.	Yes – low CV
NGGDL	2016 (Bidding)	HyDeploy	The objective is to demonstrate that natural gas containing levels of hydrogen beyond those in the GS(M)R specification can be distributed and utilised safely & efficiently in a representative section of the UK distribution network. Successful demonstration has the potential to facilitate 25TWh of decarbonised heat, and more by unlocking extensive hydrogen use as exemplified by the Leeds H21 project.	Yes – low CV
NGGDL	2016 (Bidding)	Future Billing Methodology	Consumers are currently billed on the flow weighted average calorific value of the LDZ and not on the actual calorific value delivered to their property which leads to a variation in consumer bills of about £20 per year for the same energy requirement. This project aims to develop a billing methodology which more accurately represents delivered energy content, preventing unfair pricing/cross subsidies, and potentially allowing integration of lower carbon, lower calorie gases which have their entry restricted on purely commercial grounds at present.	This proposal – facilitate low and high CV inputs
NGGT	2014	In-line robotic inspection of high pressure installations	The project will demonstrate a prototype inspection robot that can be inserted into below ground pipe work at high pressure installations.	
NGGT	2015	Customer Low Cost Connections (CLoCC)	The project aims to minimise the cost and time of connections to the National Transmission System, with particular focus on unconventional gas connections. This will be achieved through challenging every aspect of the connection process.	Yes – low and high (shale gas CV unknown)

Network	Date	Project Title	Description	New gas quality initiative
NGN	2013	Low Carbon Gas Preheating	A project to test new and emerging pre-heating technologies and associated operating systems	
NGN	2015	City CNG	A project to build the UK's first scalable city-based compressed natural gas fuelling station for back to depot city based vehicles. It will use a novel charging arrangement to recover the costs of the high pressure connection over time, and provide a proof of concept business case to enable future private sector investment.	
SGN	2014	Robotics	A project to develop new robotic technologies that operate inside live gas networks, in order to repair leaking joints, manage risk of pipe fracture in larger diameter pipes and repair and replace pipeline assets.	
SGN	2014	Opening Up the Gas Market	A project to establish whether gas which sits outside the British Gas Safety (Management) Regulations standards could be used safely and efficiently in Great Britain.	Yes – high CV
SGN	2015	Real-Time Networks	The project seeks to develop, install and demonstrate a flexible 'real-time' network that would enable the GB gas network to meet current and evolving needs. The project will install and demonstrate sensing technologies, associated hardware and software, and infrastructure, in a representative section of the GB gas network.	Yes – low and high CV

Appendix 15. Project Organigram

The Project organigram is shown in Figure A15.1.

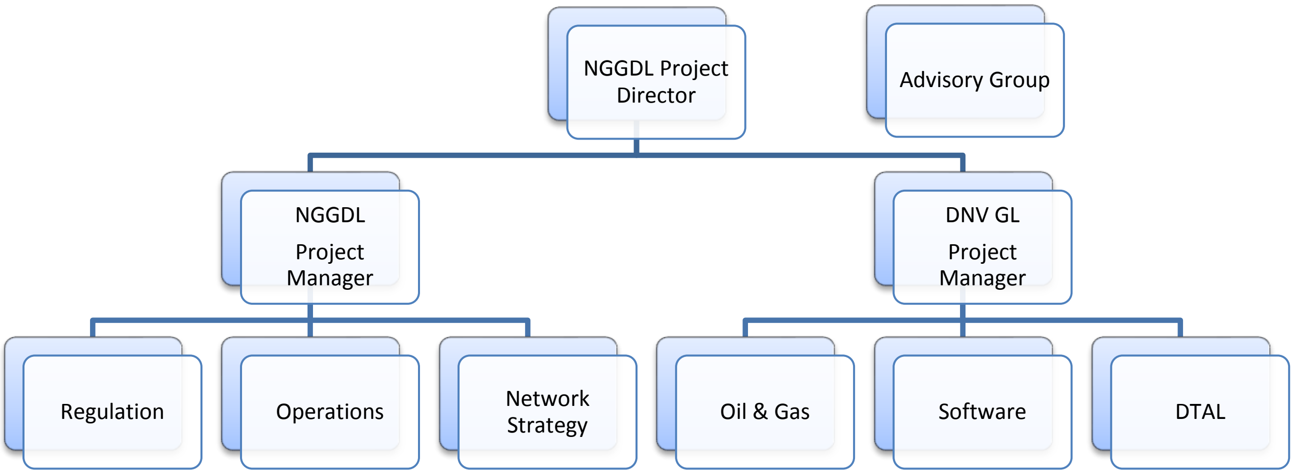


Figure A15.1: Project organigram

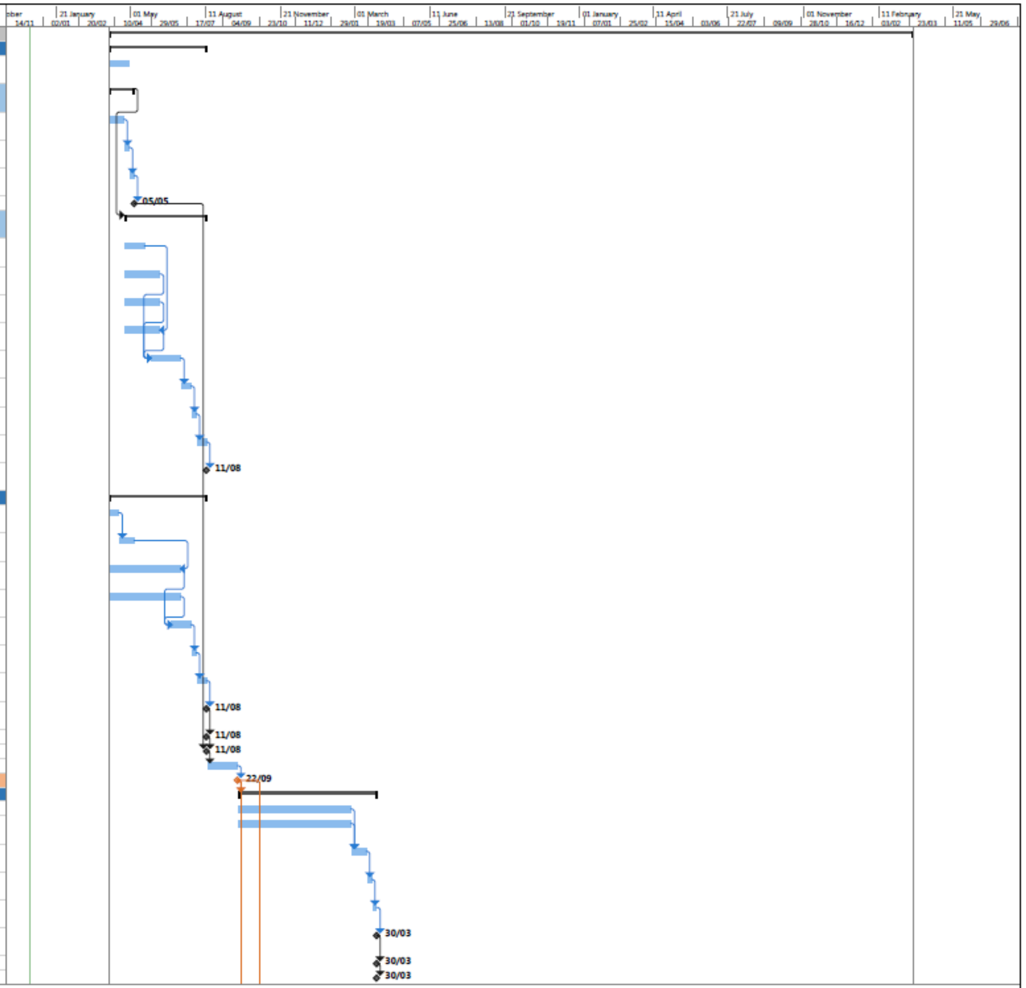
DTAL – DNV GL's Technical Assurance Laboratory

ofgem

RIIO NIC NETWORK INNOVATION COMPETITION

Appendix 16. Project Plan – note that holidays are excluded and minor changes may occur when the Project starts

ID	Task Mode	Task Name	Duration	Start	Finish
1		**Project**	**780 days**	**Mon 03/04/17**	**Fri 27/03/20**
2		**WP01a: Industry Engagement - Phase 1**	**95 days**	**Mon 03/04/17**	**Fri 11/08/17**
3		Project startup activities	20 days	Mon 03/04/17	Fri 28/04/17
4		**MS02 - Terms of reference for industry engagement**	**25 days**	**Mon 03/04/17**	**Fri 05/05/17**
5		Draft terms of reference for industry engagement	15 days	Mon 03/04/17	Fri 21/04/17
6		NGGD review	5 days	Mon 24/04/17	Fri 28/04/17
7		Update final terms of reference for industry engagement	5 days	Mon 01/05/17	Fri 05/05/17
8		*Milestone 2*	0 days	Fri 05/05/17	*Fri 05/05/17*
9		**MS09a - Undertake Phase 1 industry engagement and compile responses**	**80 days**	**Mon 24/04/17**	**Fri 11/08/17**
10		Prepare engagement material	20 days	Mon 24/04/17	Fri 19/05/17
11		Network Modelling validation requirement	35 days	Mon 24/04/17	Fri 09/06/17
12		Initial Cost Benefit Analysis	35 days	Mon 24/04/17	Fri 09/06/17
13		Engagement activities	35 days	Mon 24/04/17	Fri 09/06/17
14		Assess draft engagement responses	30 days	Mon 29/05/17	Fri 07/07/17
15		Draft Industry Eng. SG01 report	10 days	Mon 10/07/17	Fri 21/07/17
16		NGGD review	5 days	Mon 24/07/17	Fri 28/07/17
17		Update & finalise Industry Eng. SG01 report	10 days	Mon 31/07/17	Fri 11/08/17
18		Issue Final Industry Eng. SG01 Report	0 days	Fri 11/08/17	Fri 11/08/17
19		**WP02a: Initial Sensor Design**	**95 days**	**Mon 03/04/17**	**Fri 11/08/17**
20		Identify network measurement points	10 days	Mon 03/04/17	Fri 14/04/17
21		Initial Sensor site surveys	15 days	Mon 17/04/17	Fri 05/05/17
22		Initial sensor design	70 days	Mon 03/04/17	Fri 07/07/17
23		Proof of concept network modelling	70 days	Mon 03/04/17	Fri 07/07/17
24		Draft Initial Design Report	20 days	Mon 26/06/17	Fri 21/07/17
25		NGGD review	5 days	Mon 24/07/17	Fri 28/07/17
26		Update initial sensor design report	10 days	Mon 31/07/17	Fri 11/08/17
27		Issue Final Report	0 days	Fri 11/08/17	Fri 11/08/17
28		*Milestone 9a*	0 days	Fri 11/08/17	*Fri 11/08/17*
29		SDRC 9.1a	0 days	Fri 11/08/17	Fri 11/08/17
30		**Stage Gate 01 - Ofgem review (30 working days)**	**30 days**	**Mon 14/08/17**	**Fri 22/09/17**
31		**Stage Gate 01 - Consent Milestone**	**0 days**	**Fri 22/09/17**	**Fri 22/09/17**
32		**WP01b: Industry Engagement - Phase 2**	**135 days**	**Mon 25/09/17**	**Fri 30/03/18**
33		Industry Engagement Activities	110 days	Mon 25/09/17	Fri 23/02/18
34		Review & evaluate engagement status	110 days	Mon 25/09/17	Fri 23/02/18
35		Draft Report	15 days	Mon 26/02/18	Fri 16/03/18
36		NGGD review	5 days	Mon 19/03/18	Fri 23/03/18
37		Update Final report	5 days	Mon 26/03/18	Fri 30/03/18
38		Issue Final Report	0 days	Fri 30/03/18	Fri 30/03/18
39		*Milestone 9b*	0 days	Fri 30/03/18	*Fri 30/03/18*
40		SDRC 9.1b	0 days	Fri 30/03/18	Fri 30/03/18



Project: Future Billing Methodo
Date: Thu 15/12/16

Task | Split | Milestone | Summary | Project Summary | Inactive Task | Inactive Milestone | Inactive Summary | Manual Task | Duration-only | Manual Summary Rollup | Manual Summary | Start-only | Finish-only | External Tasks | External Milestone | Deadline | Progress | Manual Progress

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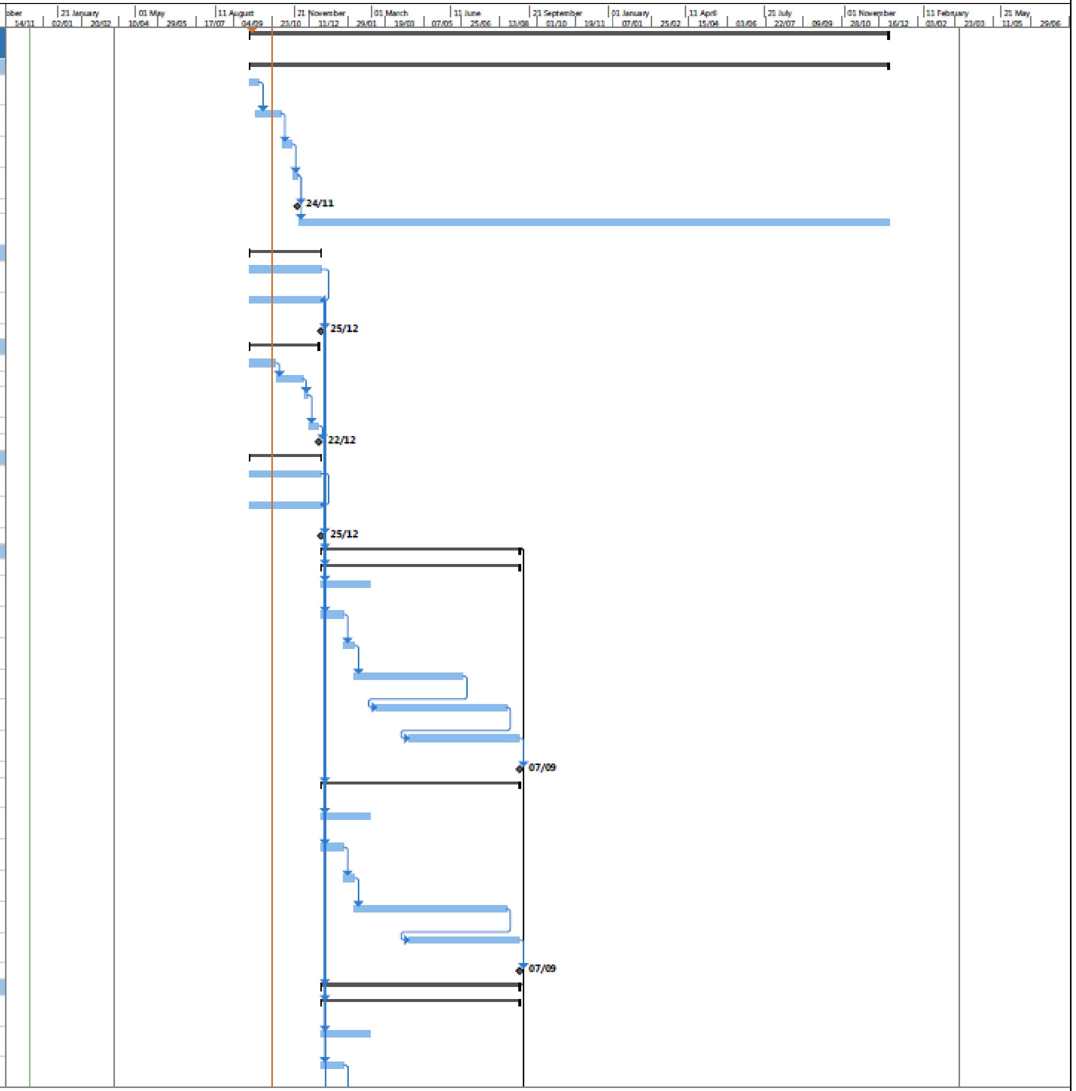
Future Billing Methodology Project

(Excludes Official Holidays)

ID		Task Mode	Task Name	Duration	Start	Finish	Predecessors
41			**WP02b: Sensors & measurement, network modelling and CV allocation**	**590 days**	**Mon 25/09/17**	**Fri 27/12/19**	**31**
42			**MS01 - QRA**	**590 days**	**Mon 25/09/17**	**Fri 27/12/19**	
43			1 day workshop with DNV GL and NGGD	10 days	Mon 25/09/17	Fri 06/10/17	
44			Draft report on QRA approach and first version of QRA document	25 days	Mon 02/10/17	Fri 03/11/17	43FS-5 days
45			NGGD review	10 days	Mon 06/11/17	Fri 17/11/17	44
46			Update & issue first version of live QRA document	5 days	Mon 20/11/17	Fri 24/11/17	45
47			*Milestone 1*	0 days	Fri 24/11/17	*Fri 24/11/17*	46
48			Updated version of live QRA document every quarter	545 days	Mon 27/11/17	Fri 27/12/19	46
49			**MS03 - Chittering field trial**	**66 days**	**Mon 25/09/17**	**Mon 25/12/17**	
50			Site survey	66 days	Mon 25/09/17	Mon 25/12/17	
51			Detailed specification of field trial	66 days	Mon 25/09/17	Mon 25/12/17	50FF
52			*Milestone 3*	0 days	Mon 25/12/17	*Mon 25/12/17*	51
53			**MS04 - Detailed specification of data collection**	**65 days**	**Mon 25/09/17**	**Fri 22/12/17**	
54			Undertake detailed spec for data collection	25 days	Mon 25/09/17	Fri 27/10/17	
55			Draft data collection specification	25 days	Mon 30/10/17	Fri 01/12/17	54
56			NGGD review & comment	5 days	Mon 04/12/17	Fri 08/12/17	55
57			Update final data collection specification	10 days	Mon 11/12/17	Fri 22/12/17	56
58			*Milestone 4*	*0 days*	*Fri 22/12/17*	*Fri 22/12/17*	*57*
59			**MS05 - Hibaldstow field trial**	**66 days**	**Mon 25/09/17**	**Mon 25/12/17**	
60			Site survey	66 days	Mon 25/09/17	Mon 25/12/17	
61			Detailed specification of field trial	66 days	Mon 25/09/17	Mon 25/12/17	60FF
62			*Milestone 5*	0 days	Mon 25/12/17	*Mon 25/12/17*	61
63			**MS07 - Inst. Equipment at Chittering**	**184 days**	**Tue 26/12/17**	**Fri 07/09/18**	**51**
64			**Subcontractor install equipment (except flow)**	**184 days**	**Tue 26/12/17**	**Fri 07/09/18**	**51**
65			Procure equipment	45 days	Tue 26/12/17	Mon 26/02/18	51
66			Design approval/appraisal	21 days	Tue 26/12/17	Tue 23/01/18	51
67			FAT readiness preparation	10 days	Wed 24/01/18	Tue 06/02/18	66
68			Factory acceptance testing (FAT)	100 days	Wed 07/02/18	Tue 26/06/18	67
69			Installation	120 days	Wed 07/03/18	Tue 21/08/18	68FS-80 days
70			Site acceptance testing (SAT)	103 days	Wed 18/04/18	Fri 07/09/18	69FS-90 days
71			*Milestone 7a*	0 days	Fri 07/09/18	*Fri 07/09/18*	70
72			**DNV GL install flow equipment**	**184 days**	**Tue 26/12/17**	**Fri 07/09/18**	**51**
73			Procure equipment	45 days	Tue 26/12/17	Mon 26/02/18	51
74			Design approval/appraisal	21 days	Tue 26/12/17	Tue 23/01/18	51
75			Lab based FAT test	10 days	Wed 24/01/18	Tue 06/02/18	74
76			Installation	140 days	Wed 07/02/18	Tue 21/08/18	75
77			Site acceptance testing (SAT)	103 days	Wed 18/04/18	Fri 07/09/18	76FS-90 days
78			*Milestone 7b*	0 days	Fri 07/09/18	*Fri 07/09/18*	77
79			**MS08 - Inst. Equipment at Hibaldstow**	**184 days**	**Tue 26/12/17**	**Fri 07/09/18**	**51**
80			**Subcontractor install equipment (except flow)**	**184 days**	**Tue 26/12/17**	**Fri 07/09/18**	**61**
81			Procure equipment	45 days	Tue 26/12/17	Mon 26/02/18	61
82			Design approval/appraisal	21 days	Tue 26/12/17	Tue 23/01/18	61



Project: Future Billing Methodo
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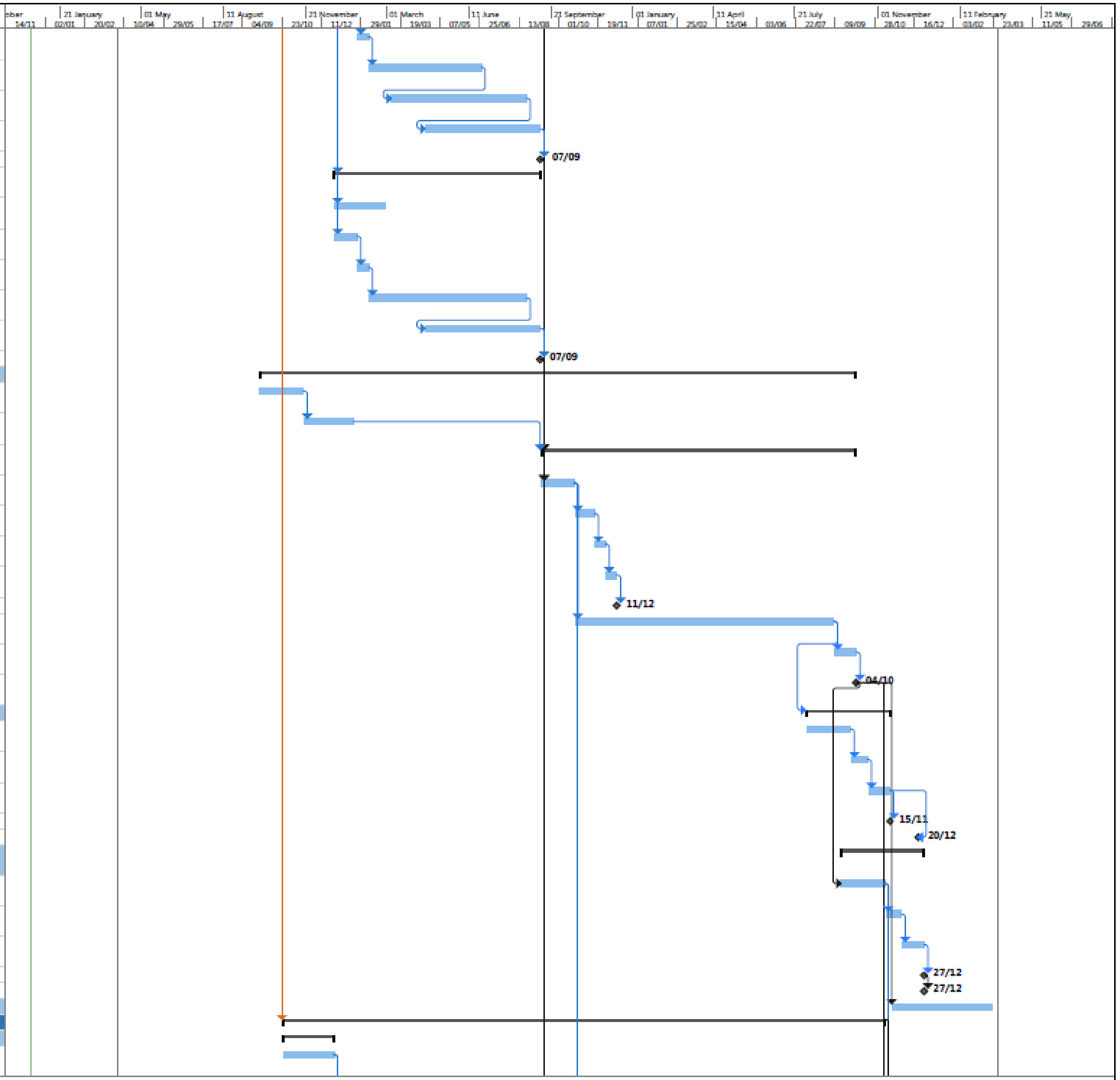
ID	Task Mode	Task Name	Duration	Start	Finish
83		FAT readiness preparation	10 days	Wed 24/01/18	Tue 06/02/18
84		Factory acceptance testing (FAT)	100 days	Wed 07/02/18	Tue 26/06/18
85		Installation	120 days	Wed 07/03/18	Tue 21/08/18
86		Site acceptance testing (SAT)	103 days	Wed 18/04/18	Fri 07/09/18
87		*Milestone 8a*	0 days	Fri 07/09/18	*Fri 07/09/18*
88		**DNV GL install flow equipment**	**184 days**	**Tue 26/12/17**	**Fri 07/09/18**
89		Procure equipment	45 days	Tue 26/12/17	Mon 26/02/18
90		Design approval/appraisal	21 days	Tue 26/12/17	Tue 23/01/18
91		Lab based FAT test	10 days	Wed 24/01/18	Tue 06/02/18
92		Installation	140 days	Wed 07/02/18	Tue 21/08/18
93		Site acceptance testing (SAT)	103 days	Wed 18/04/18	Fri 07/09/18
94		*Milestone 8b*	0 days	Fri 07/09/18	Fri 07/09/18
95		**MS10 - Interim report on progress of field trials**	**530 days**	**Mon 25/09/17**	**Fri 04/10/19**
96		Model preparation	40 days	Mon 25/09/17	Fri 17/11/17
97		Setup network models	44 days	Mon 20/11/17	Thu 18/01/18
98		**Pragmatic & Composite scenarios**	**280 days**	**Mon 10/09/18**	**Fri 04/10/19**
99		Populate with 1 month of data	30 days	Mon 10/09/18	Fri 19/10/18
100		Draft interim report (milestone 10)	17 days	Mon 22/10/18	Tue 13/11/18
101		NGGD review	10 days	Wed 14/11/18	Tue 27/11/18
102		Final interim report	10 days	Wed 28/11/18	Tue 11/12/18
103		*Milestone 10*	0 days	Tue 11/12/18	*Tue 11/12/18*
104		Populate model (On-going)	230 days	Mon 22/10/18	Fri 06/09/19
105		Finalise model	20 days	Mon 09/09/19	Fri 04/10/19
106		Analysis complete	0 days	Fri 04/10/19	Fri 04/10/19
107		**MS12 - Report on completion of field trials**	**75 days**	**Mon 05/08/19**	**Fri 15/11/19**
108		Draft final report on field trials	40 days	Mon 05/08/19	Fri 27/09/19
109		NGGD review	15 days	Mon 30/09/19	Fri 18/10/19
110		Final report on field trials	20 days	Mon 21/10/19	Fri 15/11/19
111		*Milestone 12*	0 days	Fri 15/11/19	*Fri 15/11/19*
112		*SDRC 9.2*	0 days	Fri 20/12/19	*Fri 20/12/19*
113		**MS13 - Report on completion of Network Modelling**	**75 days**	**Mon 16/09/19**	**Fri 27/12/19**
114		Draft report on options and methods for assigning CV to charging zones	40 days	Mon 16/09/19	Fri 08/11/19
115		NGGD review	15 days	Mon 11/11/19	Fri 29/11/19
116		Final report on options and methods for assigning CV to charging zones	20 days	Mon 02/12/19	Fri 27/12/19
117		*Milestone 13*	0 days	Fri 27/12/19	*Fri 27/12/19*
118		*SDRC 9.3*	0 days	Fri 27/12/19	*Fri 27/12/19*
119		**Decommisioning**	**90 days**	**Mon 18/11/19**	**Fri 20/03/20**
120		**WP03: Assigning a CV to Smart Meters**	**533 days**	**Wed 25/10/17**	**Fri 08/11/19**
121		**MS06 - Define SMART Meter Lab Spec**	**44 days**	**Wed 25/10/17**	**Mon 25/12/17**
122		Define specification for laboratory simulation of smart meter CV data collection	44 days	Wed 25/10/17	Mon 25/12/17



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Task, Split, Milestone, Summary, Project Summary, Inactive Task, Inactive Milestone, Inactive Summary, Manual Task, Duration-only, Manual Summary Rollup, Manual Summary, Start-only, Finish-only, External Tasks, External Milestone, Deadline, Progress, Manual Progress

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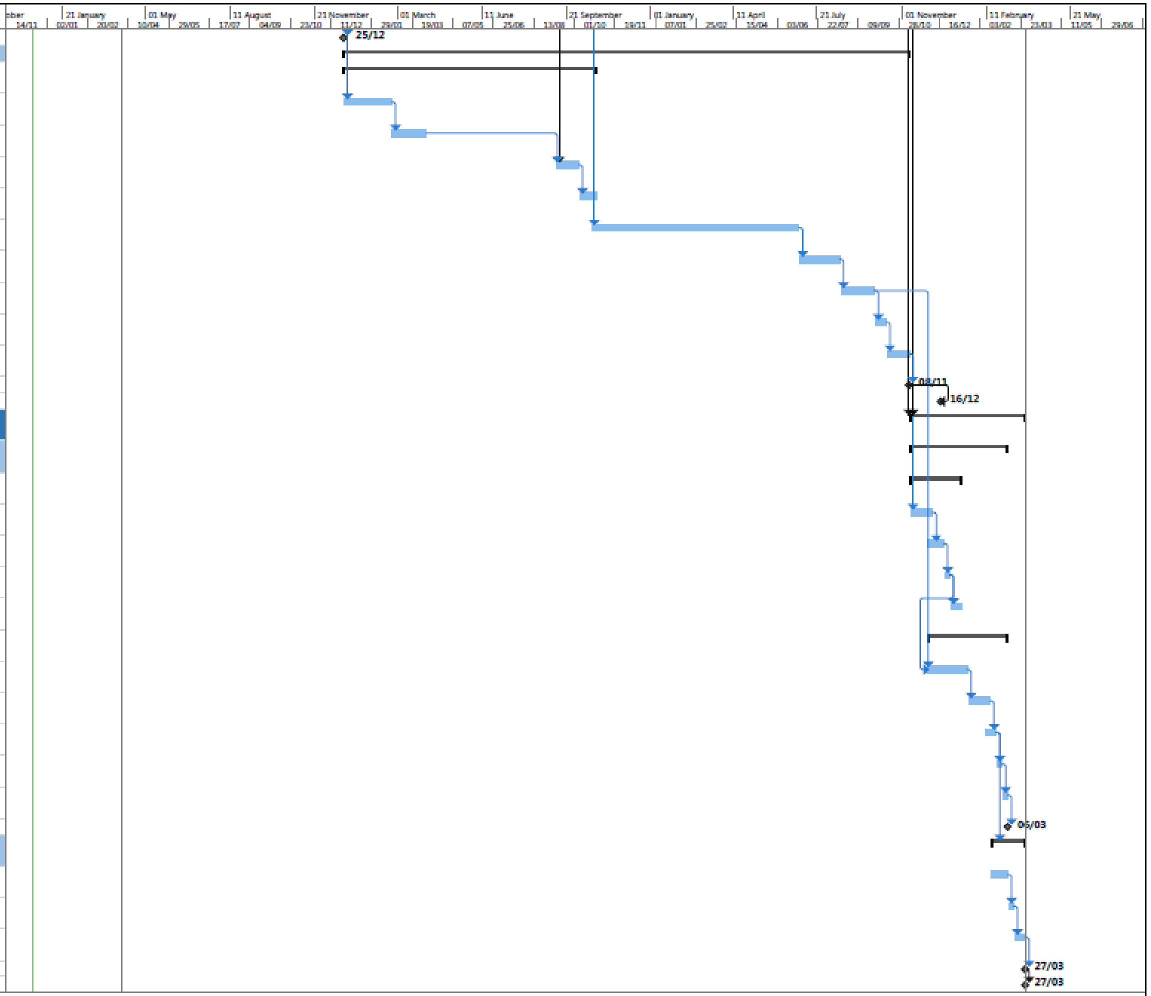
ID	Task Mode	Task Name	Duration	Start	Finish
123		*Milestone 6*	0 days	Mon 25/12/17	*Mon 25/12/17*
124		**MS11 - Smart meter Laboratory trials & report**	**489 days**	**Tue 26/12/17**	**Fri 08/11/19**
125		**Install equipment**	**219 days**	**Tue 26/12/17**	**Fri 26/10/18**
126		Procure equipment	42 days	Tue 26/12/17	Wed 21/02/18
127		Install	30 days	Thu 22/02/18	Wed 04/04/18
128		Interface with field trial CV data	20 days	Mon 10/09/18	Fri 05/10/18
129		Commission	15 days	Mon 08/10/18	Fri 26/10/18
130		Run trial	180 days	Mon 22/10/18	Fri 28/06/19
131		Analyse results	35 days	Mon 01/07/19	Fri 16/08/19
132		Draft report on smart meter laboratory trials	30 days	Mon 19/08/19	Fri 27/09/19
133		NGGD review	10 days	Mon 30/09/19	Fri 11/10/19
134		Final report on smart meter laboratory trials	20 days	Mon 14/10/19	Fri 08/11/19
135		*Milestone 11*	0 days	Fri 08/11/19	Fri 08/11/19
136		*SDRC 9.4*	*0 days*	*Mon 16/12/19*	*Mon 16/12/19*
137		**WP04: Industry Engagement on the Options, Cost-benefit Analysis with a Recommended Solution**	**100 days**	**Mon 11/11/19**	**Fri 27/03/20**
138		**MS14 - Industry engagement and knowledge dissemination**	**85 days**	**Mon 11/11/19**	**Fri 06/03/20**
139		**Cost benefit analysis of three scenarios - pragmatic, composite and ultimate**	**45 days**	**Mon 11/11/19**	**Fri 10/01/20**
140		Cost benfit analysis (CBA)	20 days	Mon 11/11/19	Fri 06/12/19
141		Draft report on CBA	15 days	Mon 02/12/19	Fri 20/12/19
142		NGGD review	5 days	Mon 23/12/19	Fri 27/12/19
143		Final report on CBA	10 days	Mon 30/12/19	Fri 10/01/20
144		**Industry engagement and knowledge dissemination**	**70 days**	**Mon 02/12/19**	**Fri 06/03/20**
145		Prepare engagement material	35 days	Mon 02/12/19	Fri 17/01/20
146		Engagement and dissemination activities	20 days	Mon 20/01/20	Fri 14/02/20
147		Draft report on engagement response	10 days	Mon 10/02/20	Fri 21/02/20
148		NGGD review	5 days	Mon 24/02/20	Fri 28/02/20
149		Final report on engagement response	5 days	Mon 02/03/20	Fri 06/03/20
150		*Milestone 14*	0 days	Fri 06/03/20	*Fri 06/03/20*
151		**MS15 - Recommendations for future billing methodology**	**30 days**	**Mon 17/02/20**	**Fri 27/03/20**
152		Draft document defining recommendations for future billing methodology	15 days	Mon 17/02/20	Fri 06/03/20
153		NGGD review	5 days	Mon 09/03/20	Fri 13/03/20
154		Final document defining recommendations for future billing methodology	10 days	Mon 16/03/20	Fri 27/03/20
155		*Milestone 15*	0 days	Fri 27/03/20	*Fri 27/03/20*
156		*SDRC 9.5*	0 days	Fri 27/03/20	*Fri 27/03/20*



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Appendix 17. Risk Register

Scoring Key

16 to 25	10 to 15	1 to 9

ID	Risk	Business risk	Inherent Risk Likelihood	Inherent Risk Impact	Inherent Risk Score	Controls & Mitigation	Status	Residual Risk Likelihood	Residual Risk Impact	Residual Risk Score
001	This is an innovation project involving the development and validation of novel methodologies. There is a risk that the methodologies cannot be validated by the field trials, that the sensors may not operate or be fully suitable for the application, or that the modelling cannot be made to work satisfactorily. This would impact on project costs/timeline/completion of associated milestone and potentially affect the project benefits.	Technical	3	5	**15**	1. Ensure all stakeholders aware and set expectations 2. Ensure reasonable steps taken in technical selection and testing of equipment prior to final acceptance 3. Technical review and monitoring throughout the project	Open	2	5	**10**
002	Contract agreement and SOW between NGGDL and DNV GL and sub-contractors not completed to allow commencement of the project on 1/4/17. This could cause delay to the project start date. On commencement the DNV GL/NGGDL contract terms must be cascaded to subcontractors to allow award of contract and commencement of services.	Schedule	4	5	**20**	1. Early proactive engagement of all parties 2. Efficient processing and agreement of the contract	Open	3	5	**15**

ID	Risk	Business risk	Inherent Risk Likelihood	Inherent Risk Impact	Inherent Risk Score	Controls & Mitigation	Status	Residual Risk Likelihood	Residual Risk Impact	Residual Risk Score
003	Negotiations with sub-contractors not completed in time for planned PO date. This would delay milestones and work packs.	Schedule	4	5	**20**	1. Engagement with subcontractor at bidding stage 2. Reasonable endeavours to agree contract asap and engage with sub-contractors to ensure agreement on sub-contract contracts asap and minimise impact of delays.	Open	3	5	**15**
004	Fixed project end date and milestones. Risk that this may not be achievable due to project delivery issues and external factors (e.g. delay to start up, delivery issues, innovation/novel use of equipment, data not being available on time/suitable). This would impact on delivery of milestones on schedule and delay the project completion date.	Schedule	4	5	**20**	1. Create, agree and manage project using a detailed project schedule 2. Risk & issue management process for the project 3. Create, agree and maintain a clear register of project dependencies 4. Pro-active and key technical and Governance assurance processes to ensure the schedule does not slip 5. Manage & ensure Milestones are delivered within specified time frame 6. Frequent progress meetings, reports and communications 7. Consider the use of penalties for late delivery in contract with sub-contractor	Open	2	5	**10**
005	NGGDL review/approval times, processing of milestones and request for information or support could cause delay to project delivery	Schedule	3	4	**12**	1. Review and agree detailed turnaround time for NGGDL related activities during contract negotiation stage to minimise any potential delay. 2. NGGDL resource planning and support to facilitate required turnaround.	Open	2	4	**8**

ID	Risk	Business risk	Inherent Risk Likelihood	Inherent Risk Impact	Inherent Risk Score	Controls & Mitigation	Status	Residual Risk Likelihood	Residual Risk Impact	Residual Risk Score
006	The detailed project scope of work and acceptance criteria for each milestone are to be further defined during commencement of each individual milestone. Risk of scope creep.	Scope creep	3	5	15	1. Detailed contractual discussions with NGGDL to agree the scope and this is cascaded down to Contractors in the terms and condtions. 2. Detailed specification for installations supported by extensive discussions with potential suppliers	Open	2	5	10
007	Failure to deliver on interdependent tasks delay delivery of other tasks and the project.	Task inter-dependencies	3	4	12	1. Tasks have been designed to run in parallel and be undertaken by separate resources (where possible) to mitigate the likelihood of this. 2. Clear planning and monitoring of tasks and their interdependencies	Open	2	4	8
008	Tracking biomethane through the network using flow, oxygen and pressure measurements do not provide data required.	Technical	3	5	15	1. Ensure all stakeholders aware and set expectations 2. Ensure reasonable steps taken in technical specification and testing of equipment prior to final acceptance 3. Technical review and monitoring throughout the project 4. Monitoring of multiple parameters to spread the risk of one or more measurements not providing sufficient data	Open	2	4	8
009	Biomethane sites may not operate and perform as required and/or may not provide valid data for the purposes of the project and model (O2).	Technical	3	5	15	1. Ensure all stakeholders aware and set expectations 2. Ensure reasonable steps taken in technical selection and testing of equipment prior to final acceptance 3. Technical review and monitoring throughout the project	Open	2	4	8

ID	Risk	Business risk	Inherent Risk Likelihood	Inherent Risk Impact	Inherent Risk Score	Controls & Mitigation	Status	Residual Risk Likelihood	Residual Risk Impact	Residual Risk Score
010	Availability of key equipment. Key equipment such as sensors, power supplies and communication equipment suitable for use with a low pressure natural gas supply may not be readily available, require further development, have long lead times or be more expensive than expected	Technical	3	4	12	1. Ensure all stakeholders aware and set expectations 2. Ensure reasonable steps taken in technical selection and testing of equipment prior to final acceptance 3. Technical review and monitoring throughout the project	Open	2	4	8
011	Risk that key resources may have unplanned absence or leave their respective organisations and not be available to the project as planned.	Resources	3	4	12	1. Evaluate the individual risks and review mitigations for key project team members 2. Monitor and review with appropriate mitigation actions.	Open	2	4	8
012	Availability and access to personnel. Many resources have multiple roles and commitments within their organisation, and may experience competing deadlines and deliveries at some point in time during this project. Over a period of 3 years, it is also likely that organisations will change as markets and other conditions evolve. Continuity of tasks may be negatively impacted.	Resources	3	4	12	1. All participants to firmly organise their workloads within this project such that task resources can be effectively distributed between project team members. 2. Impact from other NIC project assessed to me minimal. 3. Review and agree an escalation process as part of the project initiation stage	Open	2	4	8
013	Risks in the identification of suitable existing measurement sites. Identification of new measurement sites which may be below ground, or in difficult locations.	Technical	3	4	12	Detailed site surveys at the design stage including options for reducing scope without compromising project delivery. Seek alternative/additional sites if original choices prove unsuitable	Open	2	4	8
014	Site and infrastructure condition/asbestos and location/access to pipelines. Project assumption is that the condition of NGGDL assets are unsuitable for safe installation of proposed equipment. Risk if not suitable are significant delays and additional costs.	Technical	2	4	8	NGGDL should accept responsibility for asset conditions and any remedial costs required before installation can begin.	Open	2	4	8

ID	Risk	Business risk	Inherent Risk			Controls & Mitigation	Status	Residual Risk		
			Likelihood	Impact	Score			Likelihood	Impact	Score
015	Tracer compound. Risk that oxygen concentration is unsuitable for tracing the gas flow in the networks. If not suitable there will be significant delays and additional costs.	Technical	3	4	12	Verified with NGGDL that significant levels of oxygen are present in the network in the field trial area and sites carefully selected to provide accurate monitoring in the network.	Open	3	4	12
016	Demand level variations. There is a risk that the weather variations within the trial LDZs and project time period may not provide sufficient high and low demand periods	Technical	2	3	6	Two different networks have been costed for. A 12 month schedule is planned for the field trial which offers some contingency	Open	2	2	4
017	Network modelling approach. Accurate data from the O2, flow and pressure monitoring sites will be required and appropriate testing and maintenance of the equipment should be carried out	Technical	2	4	8	Ensure O2, flow and pressure monitoring is appropriate and is maintained under contract with an acceptable service level agreement.	Open	1	4	4
018	Gas quality modelling approach. Accurate data for the offtakes/entry points will be required including some understanding of the zones of influence from each offtake.	Technical	2	3	6	DNV GL to engage with NGGDL to access appropriate data	Open	2	3	6
019	Network review - NGGDL resources. NGGDL staff involved in model build process are not available.	Technical	1	5	5	DNV GL to work with NGGDL innovation team to ensure engagement with the business. As the project continues, DNV GL will identify the need for links into the business and look to the innovation team to support and establish.	Open	1	4	4
020	Delays related to site conditions. Weather/flooding etc - The installation commences in the autumn season. Impact would be on project delivery timeline and potential cost implication.	Technical	3	3	9	Assess risks and review with sub-contractor/NGGDL following the site surveys.	Open	2	3	6

ID	Risk	Business risk	Inherent Risk Likelihood	Inherent Risk Impact	Inherent Risk Score	Controls & Mitigation	Status	Residual Risk Likelihood	Residual Risk Impact	Residual Risk Score
021	Delays to sensor installation schedule due to site land owner/third party issues/traffic mgt plan plus permissions/way leaves etc. Impact would be on project delivery timeline and potential cost implication. DNV GL do not have contingency funds for this risk and there is limited time contingency.	Technical	4	4	**16**	1. Assess risks and review with sub-contractor/NGGDL following the site surveys. 2. Obtain early visability of requirements 3. Effective and early engagement by NGGDL with land owners, Highways Agency and Local Authority etc 4. NGGDL to allocate sufficient funds for this activity	Open	2	3	**6**
022	Risk of late Project delivery due to compression of Project activities to accommodate Ofgem stage gate	Delivery Time & Technical	4	4	**16**	1. Optimise Work Pack 2 activities prior to and immediately following Ofgem stage gate so that commencement of measurement is not delayed. 2. Rigorous factory and site acceptance testing 3. Knowledgeable and experienced contractors appointed to carry out design and installation of sensors on NGGDL assets.	Open	3	3	**9**

ID	Risk	Business risk	Inherent Risk Likelihood	Inherent Risk Impact	Inherent Risk Score	Controls & Mitigation	Status	Residual Risk Likelihood	Residual Risk Impact	Residual Risk Score
023	Loss measurement contingency time due to compression of Project activities to accommodate Ofgem stage gate	Delivery Time & Technical	3	5	15	1. Optimise Work Pack 2 activities prior to and immediately following Ofgem stage gate so that commencement of measurement is not delayed. 2. Rigorous factory and site acceptance testing 3. Knowledgeable and experienced contractors appointed to carry out design and installation of sensors on NGGDL assets. 4. Track record of reliability	Open	2	4	8
024	Timing of decommissioning	Delivery Time and Financial	4	4	16	1. Early engagement of operations management 2. Include minimal disruption during decommissioning during design	Open	2	2	4

Appendix 18. Glossary

Abbreviations

AD	Anaerobic digestion
AQ	Annual Quantity (Energy demand in kWh)
bcm	Billion cubic meters
BEIS	Department of Business, Energy and Industrial Strategy
BM	biomethane
CBA	Costs and benefits analysis
CEF	Carbon dioxide emission factor
CV	Calorific value
DCC	Data Communications Company
DECC	Department of Energy and Climate Control
DMS	Dimethyl sulphide
DTAL	DNV GL Technical Assurance Laboratory
DUKES	Digest of UK Energy Statistics
FAT	Factory Acceptance Test
FWACV	Flow weighted average calorific value
GC	Gas chromatograph
GDN	Gas Distribution Network
GIIGNL	International Group of Liquefied Natural Gas Importers
GS(M)R	Gas Safety (Management) Regulations
HHV	Higher (gross) heating value
HSE	Health, Safety and Environment
IEA	International Energy Agency
IGE	Institute of Gas Engineers
IHD	In home display
IP	Intermediate pressure
ISP	Initial Screening Process
LDZ	Local Distribution Zone
LHV	Lower (net) heating value
LIN	Liquid nitrogen
LNG	Liquefied natural gas
LP	Low pressure
MP	Medium pressure
MPRN	Meter point reference number
NGGDL	National Grid Gas Distribution
NGV	Natural gas vehicle
NIA	Network Innovation Allowance
NIC	Network Innovation Competition
NPV	Net Present Value
NTS	National transmission system
QRA	Quantitative risk analysis
RHI	Renewable heat incentive
RIIO	Revenues = Incentives + Innovation + Outputs
RPI	Retail price index
SAT	Site Acceptance Test

Scf	Standard cubic feet
SDRC	Successful delivery reward criteria
SMETS	Smart metering equipment technical specifications
SMETS2	Smart metering equipment technical specifications, second version
SNG	Synthetic natural gas
TBM	Tertiary butyl mercaptan
UKCS	United Kingdom Continental Shelf
UNC	Unified Network Code
WI	Wobbe Index

Appendix 19. Letters of Support

nationalgrid

National Grid House,
Warwick Technology Park,
Gallows Hill,
Warwick,
CV34 6DA.

Mr Andy Lewis
Brick Kiln Street,
Hinckley,
LE10 0NA.

27th July 2016

Dear Andy,

Re: Future of Billing Methodology Application to the Network Innovation Competition

National Grid Gas Transmission (NGGT) is the sole and operator of gas transmission infrastructure in the UK. We recognise that the UK remains committed to reducing greenhouse gas emissions by 80% by 2050 and as such we are supportive of the Future Billing Methodology Project and the need to review the commercial arrangements surrounding the billing of energy in a way which could better support the network system transportation of gas from more diverse sources.

We believe this could provide both a lower carbon and more cost-effective gas grid, as it would better facilitate the use of a diverse range of gas, whilst removing the need for expensive additional processing.

This project builds upon previous work and could thus support the journey to a low carbon energy future.

We look forward to seeing this project develop and the conclusions it reaches.

Yours sincerely,

Tamsin Kashap
Gas Transmission Innovation Manager

Northern Gas Networks

Northern Gas Networks Limited
[illegible]
[illegible]
[illegible]
[illegible]
[illegible]
[illegible]
[illegible]
[illegible]
www.northerngasnetworks.co.uk

14 July 2016

Andy Lewis
Project Delivery Specialist
Network Innovation
Network Strategy
Gas Distribution

Dear Andy

RE: Future of Billing Methodology Application to the Network Innovation Competition

Northern Gas Networks own all the gas mains in the North East, most of Yorkshire and northern Cumbria transporting gas to 2.7 million homes and businesses.

The network consists of 37,000km of gas mains, enough to stretch from Leeds to Sydney, Australia and back. Our mains replacement programme will see 3,500km of old metal gas main replaced with modern plastic equivalents by 2021.

We recognise that the UK remains committed to reducing greenhouse gas emissions by 80% by 2050 and Northern Gas Networks believes that the continued use and decarbonisation of our gas grid is essential to achieving this.

We are supportive of the Future Billing Methodology Project and the need to review the commercial arrangements surrounding the billing of energy in a way which could better support the wholesale transportation of gas from more diverse sources.

We believe this could provide both a lower carbon and more cost-effective gas grid, as it would better facilitate the use of bio-methane from anaerobic digestion and bio-synthetic gas (both recycling waste), together with other sources such as LNG or shale, whilst removing the need for expensive additional processing such as adding Propane or Nitrogen to standardise energy content.

This project builds upon previous projects and it could thus help to realise the environmental benefit of bio-methane from waste and could also support the deployment of Hydrogen in the Gas Distribution grid, where practicable; all key steps in the journey to a low carbon energy future.

We look forward to seeing this project develop and the conclusions it reaches.

Yours sincerely

Andy Irwin
Head of Energy Futures & Innovation

24 hour gas escape
number 0800 111 999*

WALES&WEST UTILITIES

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

Tŷ Wales & West
Spooner Close
Celtic Springs
Coedcernyw
Casnewydd NP10 8FZ

Telephone/Ffôn: 0800 912 29 99
Fax/Ffacs: 0870 1450076
Email/E-bost: enquiries@wwutilities.co.uk
www.wwutilities.co.uk

F.A.O. Andy Lewis
National Grid Gas Distribution
Brick Kiln Street
Hinckley
Leicester
LE10 0NA

28 July 2016

Dear Andy

RE: Future of Billing Methodology Application to the Network Innovation Competition

Every day at Wales & West Utilities, our team of more than 1,300 skilled and dedicated colleagues do their very best to keep our 7.5 million customers safe and warm, with gas connections and a gas supply they can rely on combined with a level of service they can trust.

We launched Wales & West Utilities in 2005, and since then we have worked hard to build our impressive and established reputation for delivering excellent customer service with safety, reliability and value for money at the heart of everything we do.

We recognise that the UK remains committed to reducing greenhouse gas emissions by 80% by 2050 and WWU believes that the continued use and decarbonisation of our gas grid is essential to achieving this.

We are supportive of the Future Billing Methodology Project and the need to review the commercial arrangements surrounding the billing of energy in a way which could better support the wholesale transportation of gas from more diverse sources.

We believe this could provide both a lower carbon and more cost-effective gas grid, as it would better facilitate the use of bio-methane from anaerobic digestion and bio-synthetic gas (both recycling waste), together with other sources such as LNG or shale, whilst removing the need for expensive additional processing such as adding Propane or Nitrogen to standardise energy content.

This project builds upon previous projects and it could thus help to realise the environmental benefit of bio-methane from waste and could also support the deployment of Hydrogen in the Gas Distribution grid, where practicable; all key steps in the journey to a low carbon energy future.

We look forward to seeing this project develop and the conclusions it reaches.

Yours sincerely

Nicola Evans
Business Performance Senior Manager

Smell gas? Call us!
Arogli nwy? Ffoniwch ni!
0800 111 999

Institute of Customer Service

cng services ltd

Virginia House
56 Warwick Road
Olton
Solihull
B92 7HX

Tel: 0121 247 0160
Email: info@cngservices.co.uk
Web: www.cngservices.co.uk

26th July 2016

Andy Lewis
National Grid Gas Distribution
Brick Kiln Street
Hinckley
Leicestershire LE10 0NA

RE: Future of Billing Methodology to the Network Innovation Competition

Dear Andy,

CNG Services Ltd (CSL) works in the biomethane market and also provides engineering support to shale gas developers who are aiming to inject gas into the gas grid.

We were involved in the Ofgem FMIB review and in discussions related to the agreement of the industry biomethane projects should meet the FWACV of the gas grid. As a result of the 70 biomethane projects completed to date, all have had propane injection equipment installed as part of the project.

We are supportive of the Future Billing Methodology Project and the need to review the commercial arrangements surrounding the billing of energy in a way which will support both the biomethane (and Bio-SNG) and shale gas industries if it allows injection of unenriched gas.

We look forward to seeing this project develop and the conclusions it reaches.

Yours sincerely,

T J Baldwin

Managing Director

UKOOG United Kingdom Onshore Oil and Gas

United Kingdom Onshore Oil and Gas
40 Dukes Place
London EC3A 7NH

Andy Lewis
National Grid Gas Distribution
Brick Kiln Street
Hinckley
Leicestershire LE10 0NA

4 August 2016

Network Innovation Competition 2016 – Future of Billing Methodology project

Dear Andy

I write to confirm the support of United Kingdom Onshore Oil and Gas (UKOOG) for the submission by National Grid Gas Distribution to the Network Innovation Competition 2016 – "Future of Billing Methodology". UKOOG is the trade association for the onshore oil and gas industry and supply chain.

Natural gas heats 84% of homes in the UK, and is a vital source of electricity generation and feedstock for the petrochemical industry. It is imperative that gas continue to be delivered efficiently to the homes and businesses that need it.

Although the UK is in the fortunate position of having an extensive gas network at both the transmission and distribution levels, detailed thought needs to be given to how it can best be adapted to handle increasing volumes of gas from more diverse sources, including from biomethane and shale gas. At the same time, there is great potential to use the gas grid to transport hydrogen, and we are very supportive of efforts to decarbonise the UK's gas supply in this way.

These are both likely to be complex problems to overcome, so we are supportive of the Future Billing Methodology Project and the need to review the commercial arrangements surrounding the billing of energy in a way which could better support the wholesale transportation of gas from more diverse sources.

We believe this could provide both a lower carbon and more cost-effective gas grid. It would better facilitate the use of bio-methane from anaerobic digestion and bio-synthetic gas (both recycling waste), as well as shale and LNG, whilst removing the need for expensive additional processing such as adding propane or nitrogen to standardise energy content. It could also support the deployment of hydrogen in the gas distribution grid.

We are happy to work with National Grid Distribution to support this project, and look forward to the conclusions it reaches.

Yours sincerely

Ken Cronin
Chief Executive

ofgem

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