Future Billing Methodology

NIC04 Future Billing Methodology
Project Progress Report 5
December 2021

Our vision

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Future Billing Methodology

1. Executive Summary

The twelve months since the last Project Progress Report in December 2020 can be summarised as follows:

- Completion and publication of key output reports:
  - MS11 Report on Completion of the FBM Smart Meter Laboratory Trial
  - MS12 Report on Completion of FBM Field Trials
  - MS13 Report on Novel Validation of Network Modelling for Embedded and Network Charging Areas
- Detailed challenge and review of draft MS13 Report and future billing options
- Development of alternative Option 4 – Modelled CV
- Detailed review of Gas Calculation of Thermal Energy Regulations (as amended 1997)
- Parallel assessment of potential for working within existing regulatory framework for blending green gases such as hydrogen and biomethane
- Preparation for external consultation (Q1 2022) including joint preparatory discussions with all GDNs and National Grid NTS
- Preparation of an updated CBA for the future billing options
- Engagement with Xoserve as facilitator for industry consultation

The above has necessitated a further extension to the timetable for completion of the FBM Project, which is now scheduled to conclude at the end of Q1 2022.

Section 2 of this report summarises the output from the three key technical reports, listed above, and the options to be proposed for attributing gas calorific value (CV) for billing in the transition of Great Britain's gas distribution networks towards net zero as:

- **Option 1 – Work within existing frameworks –** involving blending of green gases such as hydrogen and biomethane within the constraints of the current GCoTER
- **Option 2 – Embedded Zone Charging** (aka FBM "Pragmatic") for embedded gas supplies of different CV
- **Option 3 – Modelled CV** (aka FBM Option 4 – Fully modelled CV) which could provide one consistent methodology for all diverse-CV gas transition scenarios

These options will be consulted upon in Q1 2022, with the final output report under SDRC 9.5 to be released by 31st March 2022, containing collated industry responses, recommendations for next steps, a final billing options CBA and a road map for implementation of the recommended option(s).

An FBM roadside kiosk installation in Cambridge

2. Project Manager's Report

Introduction

The Future Billing Methodology (FBM) NIC Project is being undertaken by Cadent, working in partnership with DNV. The FBM Project commenced in April 2017 and originally set out to explore three evolutionary options to provide a "proof-of-concept" model for a more specific way of attributing the energy content (calorific value or CV) of gas to volumes in GB's gas distribution networks for billing purposes. Further work following completion of the field trial has developed two further options. Each of the five options explored is summarised below, together with a re-prioritisation of those options which will be proposed for consultation.

Field Trials in East of England

Central to the project were two field trials completed in Cadent's East of England Network at the end of March 2021, which successfully tracked the presence of biomethane from two injection points across local gas networks under varying demand conditions, to validate the use of network planning models to create CV zones for billing. The project also included a laboratory-based smart metering trial to explore the possibility of CV transmission to gas smart meters, which was completed in late 2020.

Unlocking decarbonisation of heat

The FBM Project posited that a zonal CV billing framework driven by network modelling could provide a robust, cost-effective way to unlock the decarbonisation of heat in Great Britain, by enabling our existing gas distribution and gas transmission networks to transport renewable and other low carbon gases without the need to add in carbon-rich, fossil-based gases to standardise energy content for billing, as required by the existing regime.

Key FBM Project outputs

Since the December 2020 PPR, three of the main project output reports have been released and published on the FBM Project web site, with the fourth in the process of being uploaded at the time writing: https://futurebillingmethodology.co.uk/project_updates/

The key outputs from these reports are summarised below:

MS11 Report on Completion of the FBM Smart Meter Laboratory Trial – conclusions summary

- **Smart Meter Capability –** From the field trial, this report concluded that existing smart meters could, in principle, deliver locally derived CV data to gas smart meters (GSME), and convert this to a kWh value which could then be used for direct billing purposes, and that this could potentially provide a future platform to support a phased transition to full gas energy smart metering and billing at the point of use.
- **Need to upgrade GSME –** However, the trial identified a significant barrier in that, to apply this in practice, the existing and future population of gas smart metering equipment would need to be uprated to have active capability, rather than the existing "sleepy" default setting. This would also require upgraded battery arrangements to minimise replacement.

- **Need for GBCS use case –** The report also noted that a Great Britain Companion Specification use case would be required to enable retrieval of kWh data from smart meters, which would require a change to the industry specifications, together with the appropriate pre-implementation testing.
- **Required changes to DCC data capacity and billing systems –** This would also drive significantly increased DCC data traffic load and require change management to transit from the existing Xoserve settlement mechanism, together with impacts on Shipper/Supplier billing systems, with significant cost implications. The report also noted this work would fall outside the remit of gas transportation and would be driven principally by gas Shippers/Suppliers.
- **Question for industry consideration –** In the light of these findings, the report recommended that the industry may consider whether it would be appropriate and generally advantageous to progress such changes in the future, and that such considerations should also include the implications of a future move to hydrogen transportation, which would require hydrogen-specific GSME. If agreed, a separate industry engagement would be required to estimate the costs and timescales for implementing the necessary changes.

MS12 Report on Completion of FBM Field Trials – conclusions summary

- **Successful deployment –** The Future Billing Methodology project overcame numerous issues and successfully deployed 34 sites at suitable measurement locations. Site-by-site evaluation, taking account of cost, complexity and timing ensured a robust optimisation of the field trial site population with respect to gas zones of influence around the target embedded gas sources.
- **Effective and reliable oxygen measurement –** The installed instrumentation was suitable and the GE OXY.IQ sensor proved to be an effective and reliable instrument for successfully measuring oxygen content and hence tracking biomethane through the test networks.
- **Successful data gathering –** Except for some minor gaps in the recorded data, data was gathered and transmitted reliably from all sites which underwent successful site acceptance tests (SAT), although the Covid-19 pandemic had resulted in some site delays.
- **Data compatible for modelling & analysis –** The data gathered was compatible with the existing network models and so, appropriate to be fed into the development of modelling techniques for determining charging areas for the MS13 report.

MS13 Report on Novel Validation of Network Modelling for Embedded and Network Charging Areas – conclusions summary

- **Representative body of data –** The body of data obtained from the field trial provided a representative base for seasonal effects to be analysed. (It is worth noting here that the measurement window of the FBM field trial was extended to 31st March 2021 to ensure completeness of capture of winter data across the commissioned trial sites.)
- **Strong correlation between model and measurement –** The strong correlation demonstrated between measured and modelled oxygen levels gives confidence that network modelling can accurately predict or simulate the travel and mixing of gases under varying demand conditions and, with appropriate software, could robustly attribute CV at system node[1] level.

[1] A system node is a section of pipework, fed by specific regulators on the gas distribution system and represents the lowest level of detail at which network models could simulate gas demand from loads connected to it, and hence the travel, mixing and CV of gas.

- **Embedded charging area –** This could enable a charging area to be developed around an embedded source of gas and so remove the need for enrichment with fossil-based propane, whilst constraining billing disparities to within the range experienced under the existing LDZ flow-weighted average CV (FWACV) regime.
- **High-level methods for identifying charging areas –** The MS13 report developed several high-level methods for identifying charging areas for future billing purposes, with the intention of aligning with the current Gas (Calculation of Thermal Energy) Regulations (GCoTER), which requires allocation to one or more physical Calorific Value Determination Devices (CVDDs) when defining a Charging Area. (Please see further commentary in the GCoTER section below.) The following options all apply network modelling to allocate a consumer to a Charging Area with their billing CV measured at a CVDD:
    1. **Future Billing Option 1 "Pragmatic" –** would use network CV modelling to determine an embedded charging area within the LDZ but would apply the existing CV measurement at the embedded gas source for billing consumers within that charging area. All other consumers would be billed on the LDZ FWACV.

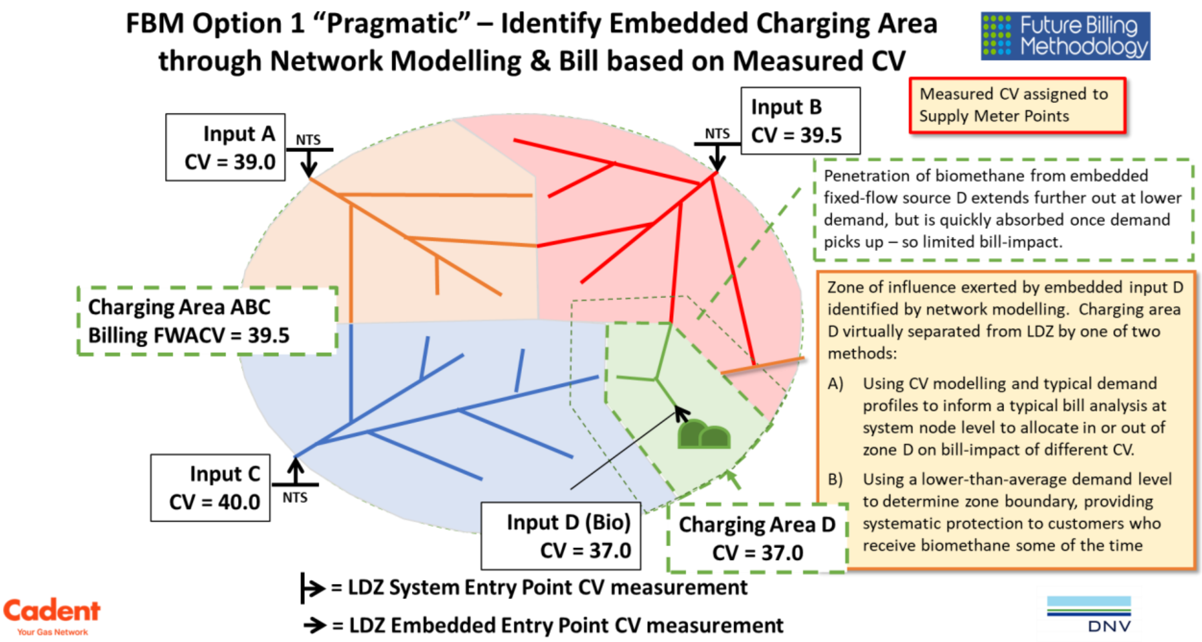

Fig. 2-1 – Illustration of the FBM Option 1 "Pragmatic" method for embedded low-CV gas supplies.

    2. **Future Billing Option 2 "Composite" –** would use a combination of network CV modelling described for Option 1 Pragmatic and the identification of single fed sections of the LDZ to determine charging areas. These charging areas would require additional CV measurement for all consumer billing. (Estimated at up to 10,000 extra CVDDs across GB networks.)

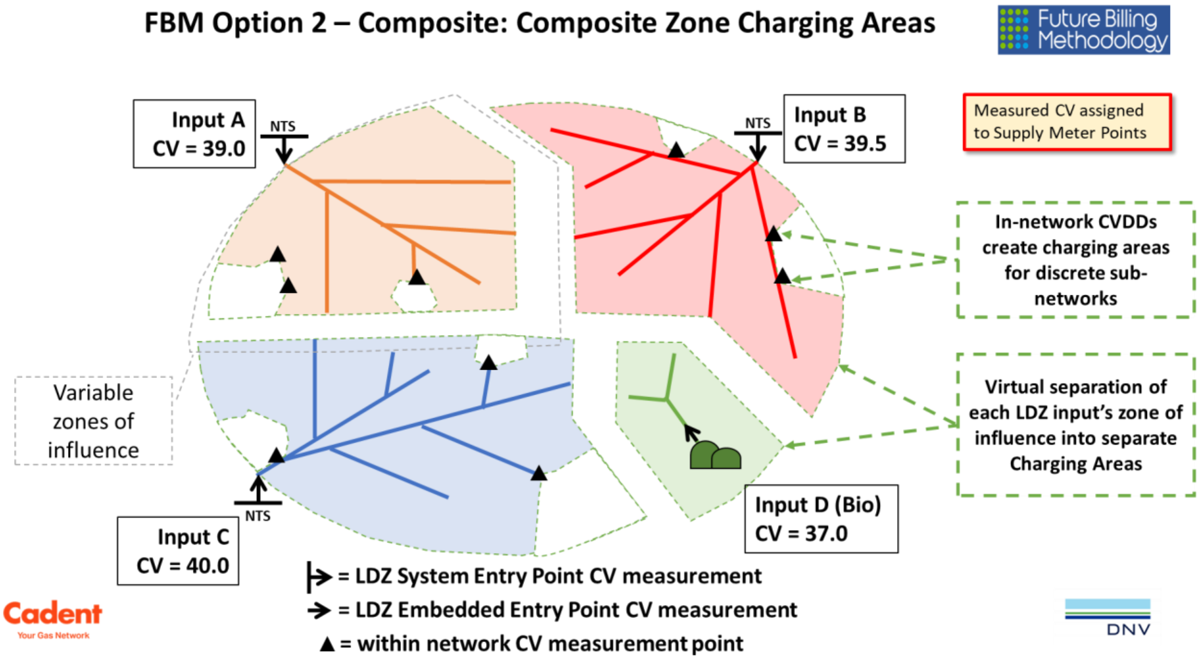

Fig. 2-2 – Illustration of the FBM Option 2 "Composite" method for diverse-CV gas supplies.

3. **Future Billing Option 3 "Ideal" –** would use network modelling to determine the optimum location for CV measurement devices to be installed locally throughout the network. From these devices, CV data could be transmitted to smart meters and/or to Smart DCC, so that the consumer could ultimately be billed directly on current gas energy use, rather than metered volume at an allocated CV (see MS11 Report summary above). (Up to 44,000 extra CVDDs across GB networks.)

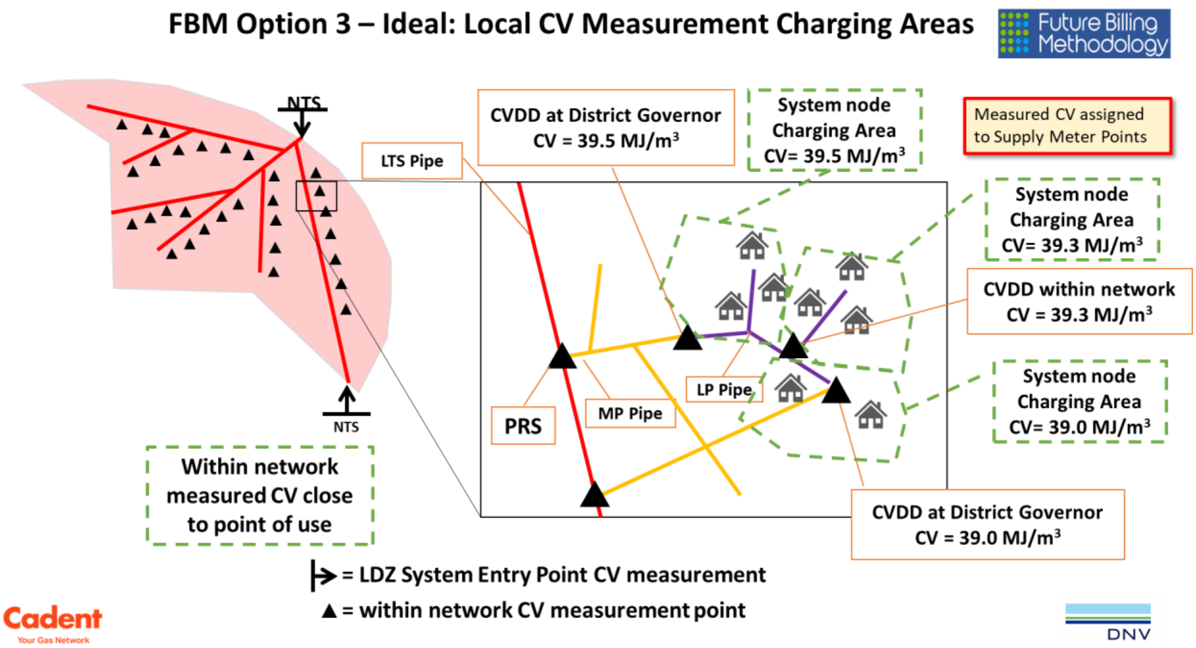

Fig. 2-3 – Illustration of the FBM Option 3 "Ideal" method for diverse-CV gas supplies.

- **Options 2 and 3 not recommended –** the MS13 report noted that the additional CV measurement requirement within Options 2 and 3 would drive very significant capital and operating costs for the installation, powering, maintenance and replacement of CV measurement devices, and without technological advances to avoid venting sampled gas, the levels of gas vented for CV measurement purposes would be unsupportable (see Table 1, below.) Although advances in gas analysis technology may overcome the need to vent sampled gas to the atmosphere, the installation, powering, maintenance, and data communications requirements for such a significant population of CVDDs would still be uneconomic and impractical in the real world. As a result, we will not recommend either Option 2 or 3 for implementation.
- **Alternative Option 4 –** An alternative approach considered in the MS13 report would use CVs measured at the LDZ entry points combined with online network modelling of the Local Transmission System (LTS) to generate modelled CVs at system node level for billing purposes:
    4. **Future Billing Option (4) "Modelled CV" –** this option would use online LTS modelling with SCADA data to provide a continually updated set of modelled CV values at the exit points from the LTS to the lower pressure tiers. This would combine the CV values measured at primary inputs to the LDZ with measured pressures and flows on the LTS to calculate the output CVs delivered by the LTS, at defined periods of time, for example hourly or daily. Allocation of a billing CV could be achieved through either:
        a) **Predictive –** undertaking upfront offline modelling of lower pressure tiers to allocate consumers to a charging area assigned to a LTS offtake for billing purposes. The billing CV would be provided by the online LTS system.
        b) **Reactive –** recreating the lower pressure tiers network state after the day using the CVs from the modelling of the LTS as one of the inputs to the downstream pressure tier models. In this case, each network analysis model system node would become a charging area and modelled CVs would be attributed to individual SMPs across the gas network.

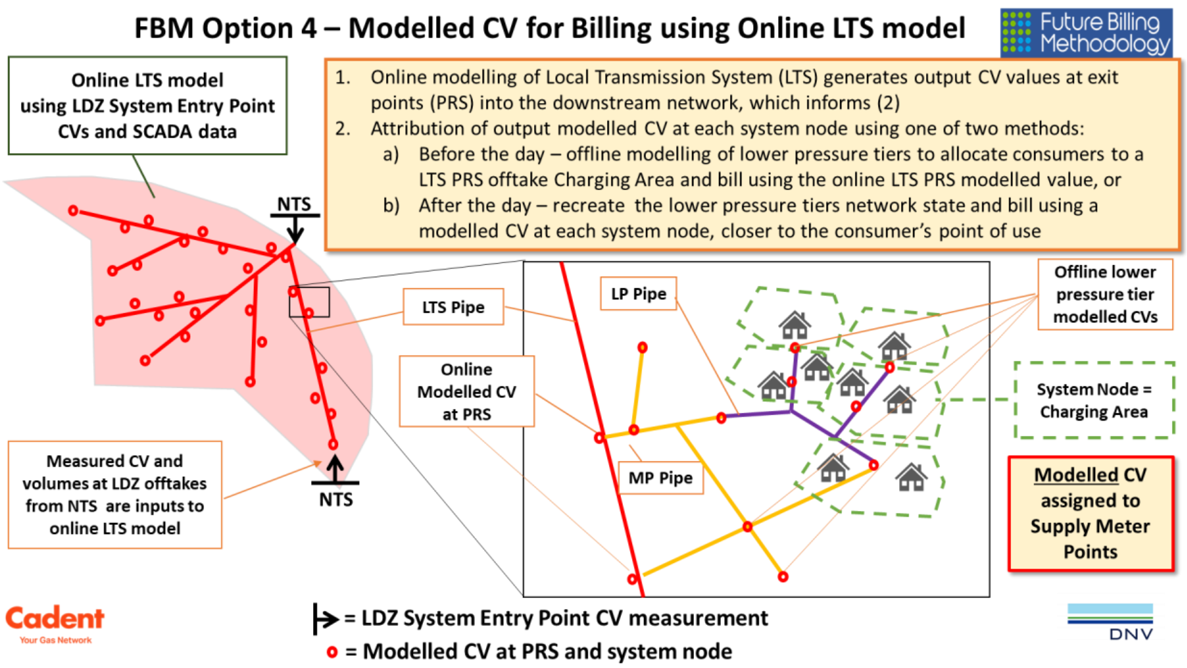

Fig. 2-4 – Illustration of the FBM Option 4 Modelled CV method for diverse-CV gas supplies.

Note: Charging areas – For FBM Options 1 and 4, a charging area, in which groups of customers would be billed based on the same CV value, a charging area would comprise one or more contiguous system nodes, in the manner illustrated in Fig. 2-4 above. (For non-recommended FBM options 2 and 3, which centre on physically measured CV within the network, charging areas would depend on siting of CVDDs and could also be impacted by physical changes to network configuration, and so, could be considerably more complex to define.)

FBM Options - indicative implementation costs

Original cost estimates – The implementation cost figures shown in table 1 below are those presented in the MS13 report. These are based on the high-level cost estimates applied in the 2017 initial CBA for the FBM Project stage gate, adjusted for RPI and rounded to avoid spurious accuracy, together with further estimates supporting option 4, modelled CV. Development of the MS13 report also considered the wider implications of within-network CV measurement at scale, using existing technology, hence additional analysis to generate indicative venting volumes and the associated cost of carbon.

BILLING REFORM OPTIONS - HIGH-LEVEL IMPLEMENTATION COST & VENTING SUMMARY

Indexed from 2017-18 to 2021-22 prices, rounded to nearest £0.1m (RPI = 303.3)

<table>
<tr><th rowspan="2">FBM OPTIONS - HIGH-LEVEL COST ESTIMATE (GB 13 LDZ BASIS)</th><th>CAPEX</th><th>OPEX (Set-up)</th><th>OPEX (On-going)</th><th>ADD'L IN-NETWK CVDD</th><th>ADD'L VENT LOAD *</th><th>VENTING CoC **</th></tr>
<tr><th>£m</th><th>£m</th><th>£m/a</th><th>No. Devices</th><th>tCO_2e/a</th><th>Total £m/a</th></tr>
<tr><td>1. NIC "Pragmatic" Option</td><td>58.0</td><td>0.3</td><td>2.4</td><td>0</td><td>0</td><td>0.0</td></tr>
<tr><td>2. NIC "Composite" Option</td><td>393.9</td><td>1.2</td><td>6.9</td><td>10,000</td><td>124,500</td><td>8.8</td></tr>
<tr><td>3. NIC "Ideal" Option</td><td>799.1</td><td>3.3</td><td>12.8</td><td>44,000</td><td>547,700</td><td>38.6</td></tr>
<tr><td>4. Modelled CV Option</td><td>81.3</td><td>3.3</td><td>5.3</td><td>500</td><td>6,200</td><td>0.4</td></tr>
</table>

** High-level indication, based on a 95:5 mix of natural gas to biomethane*
*** Evaluated using BEIS Table 3 (May 2021) central case non-traded value for 2021*

Table 2-1 – High-level FBM implementation cost estimates and projected venting from CVDDs

Recent updates – Further discussion with Xoserve and other Gas Distribution Networks on the potential depth of required system changes for future billing solutions suggests that the central systems implementation capital cost estimate could be more in line with the latest changes to facilitate faster customer switching between suppliers, which is expected to be in the region of £11m at 2021-22 prices (including contingencies). As the FBM implementation cost estimation methodology uses the core systems change cost as a reference cost for associated changes to GDN network modelling systems across 13 LDZs and for the development of the required GDN data interface with the central billing system, the increase in core cost drives a multiplicative increase to collective GDN costs. The updated cost estimates are shown below in Table 2-2.

FBM OPTIONS - HIGH-LEVEL COST ESTIMATE (GB 13 LDZ BASIS)	CAPEX	OPEX (Set-up)	OPEX (On-going)
	£m	£m	£m
1. NIC "Pragmatic" Option	162.1	0.3	2.4
2. NIC "Composite" Option	498.0	1.2	6.9
3. NIC "Ideal" Option	903.2	3.3	12.8
4. Modelled CV Option	185.4	3.3	5.3
% Change on previous estimate			
1. NIC "Pragmatic" Option	179%	0%	0%
2. NIC "Composite" Option	26%	0%	0%
3. NIC "Ideal" Option	13%	0%	0%
4. Modelled CV Option	128%	0%	0%

Table 2-2 - High-level FBM implementation cost estimates updated

The implementation cost cases shown in tables 2-1 and 2-2 above will be incorporated in the updated CBA which will accompany the industry consultation on options for the gas distribution networks transition to Net Zero for 2050.

GCoTER – The gas thermal energy regulations

Initial views – The development of potential future options for gas billing was based on a high-level view of these regulations, which suggested that since the regulations did not define charging areas in geographical terms, network modelling could be applied to create separate charging areas within a Local Distribution Zone (LDZ), within each of which customers' bills would be based on the measured CV at the relevant gas sources identified as supplying that charging area, in the manner illustrated in Fig. 2-1, for example.

Detailed view of regulations – The FBM Project undertook to examine these regulations in more detail, and from this year's detailed review, it is now clear that the regulations effectively mandate physical measurement of calorific value and volume at each connection point between charging areas (i.e., every input point and output point for each charging area), with the intention of keeping the energy calculation whole for each charging area. An alternative view had suggested that the CV declaration provisions within Part III of the regulations could be used to support CV modelling. However, the detailed review confirmed that the notification and gas CV testing arrangements set out in this part of the GCoTER could not support a dynamic network setting in which CV at any given point on the network could vary, potentially daily.

Complex gas networks – Gas distribution networks in GB can be highly meshed in populous areas, which aids pressure control, resilience, and security of supply. In a transitional diverse-CV gas network scenario, the travel and mixing of gases of differing CVs within the LDZ network could be complex. Any sub-LDZ charging area could have numerous physical connection points to other charging areas. The application of measurement in the manner required by the existing GCoTER would need to be on the scale envisaged by the FBM Option 3 – "Ideal" solution, which would be uneconomic and impractical for the reasons given in the section below Fig. 2-3, above.

Changes required to support diverse-CV gas billing – As a result, the review has clarified that the application of network modelling to configure charging areas within an LDZ would require an amendment to the existing regulations, to permit the application of a modelled CV at system node level for billing customers connected to relevant system nodes. This would not invalidate any of the proposed FBM options but would enable a move away from the “binary” requirement to align customers directly to one or other CVDD or group of CVDDs for billing and so, if proven to be robust and sufficiently accurate, could make billing more representative of customers’ actual energy usage.

FBM and Future Billing Validation

GCoTER constraint on FBM validation – The FBM field trial had to use oxygen sensors to track the presence of biomethane from the target gas input points, because propane-enrichment could not be turned off at the biomethane sites without triggering the Regulation 4A flow-weighted average CV cap which would generate significantly disproportionate CV shrinkage and associated distortion to billing as a result. For accuracy, the molecular oxygen sensors had to be set at a range of 0 – 200 ppm, which equates to a maximum mix of 10% biomethane in natural gas, so effectively detecting the outer reach of the zone of influence.

Direct CV modelling validation – Although the modelling for the FBM field trial analysis was highly accurate in simulating the measured presence of biomethane at the test sites, the implementation of a CV modelling system for gas billing would require a direct validation of CV modelling across a the range from low-CV pure biomethane, or a hydrogen blend, to natural gas. Some form of derogation would be required to support such a trial. However, the existing GCoTER does not contain any specific provision for derogation and so may need to be amended to allow this to happen.

We expect that any future implementation of an LDZ-wide network modelling-based method for attributing CV to meter points for billing would require some level of ongoing verification. We would expect this to take the form of a strategic placement of a small population of CV determination devices within the LDZ network and we are exploring the potential of new gas analysis technology which could fulfil this role without the need for venting sampled gas to the atmosphere, which is a major drawback of existing gas calorimetry equipment.

Fifth option - work within existing framework

The counterfactual solution to billing reform is to work within the existing framework. Further work has been undertaken to evaluate the potential for hydrogen and biomethane blending within the current billing methodology and regulations.

Blending NIA – During 2021 a separate NIA project, ‘*Calorific value and gas quality impact assessment of hydrogen and biomethane blends*’ was initiated by Cadent to evaluate the potential for hydrogen blending around future hydrogen supply hubs. This project identified that, where sufficient hydrogen supply exists upstream and with the necessary Gas Safety Management Regulations (GSMR) approvals and system controls in place, blending hydrogen into the natural gas supply at strategic locations could provide a significant opportunity to begin the decarbonisation process, working within the existing GCoTER Regulation 4A LDZ FWACV cap and avoiding the immediate need for changes to the existing billing regime and systems.

Hydrogen blend as minority of LDZ energy – Analysis of historical injection volumes and natural gas CV at NTS/LDZ offtakes in two of Cadent’s LDZs indicated that lower percentages of hydrogen could be blended with natural gas, at one or two candidate offtakes, i.e., as a “minority energy flow” into the LDZ without triggering the FWACV cap, as an initial phase. This could account for a significant amount of hydrogen in absolute terms and could – with supportive pricing signals – begin to stimulate the upstream hydrogen supply market at hubs.

Hydrogen blend as majority of LDZ energy - Where hydrogen blend accounts for a "majority energy flow" into the LDZ, this would enable the percentage blend of hydrogen in natural gas to be ramped up towards the 20%$_{VOL}$ safe-burn limit, in line with the increasing proportion of the LDZ energy supplied as hydrogen blend, as illustrated in the chart in Fig. 2-5 below.

Biomethane injection - Increasing the amount of LDZ energy supplied with a hydrogen blend would reduce the FWACV, which would reduce or eliminate the need for enrichment of any biomethane injection sites embedded within the LDZ. This arrangement could be GCoTER compliant without the need for changes to billing systems.

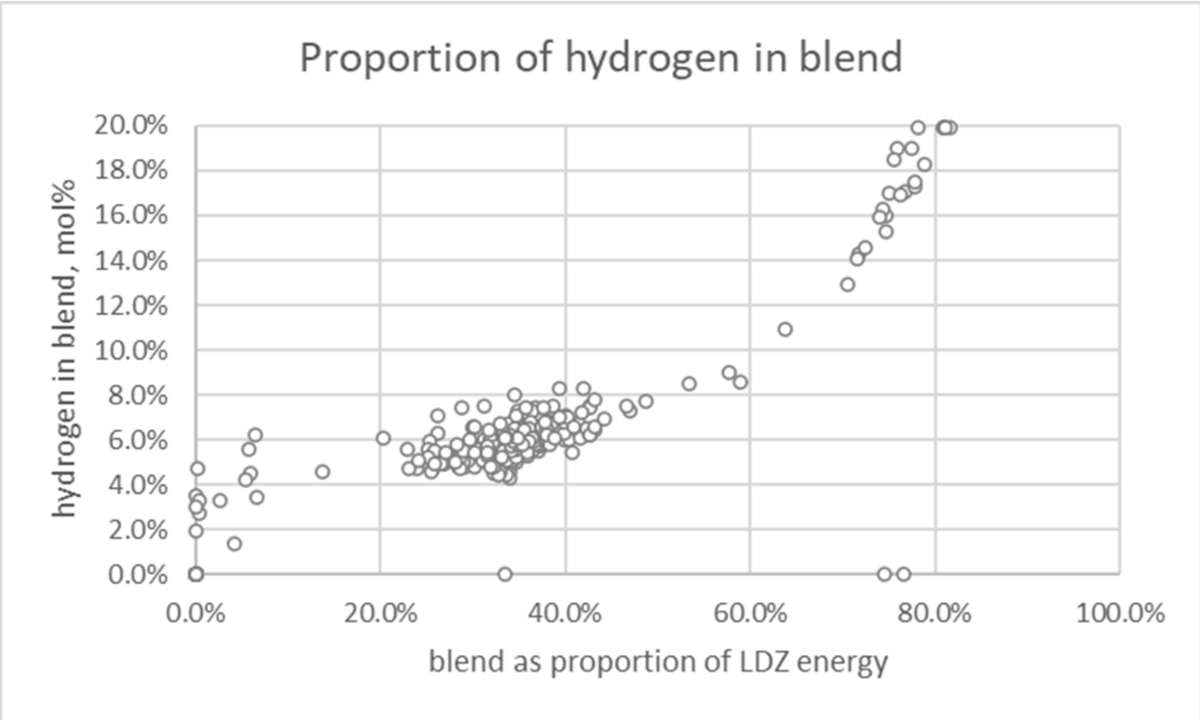

Fig 2-5 – Percentage hydrogen blend in natural gas achievable within LDZ FWACV cap, dependent on blend as proportion of total LDZ energy.

The chart above illustrates that as the proportion of LDZ energy delivered as blend (X axis) increases, this allows for a higher volumetric percentage of hydrogen (Y axis) to be blended into the native system gas, as the greater proportion of lower-CV hydrogen blend acts to decrease the flow-weighted average CV across the LDZ.

FBM / Blending consultation options

Working within the current framework provides a route to begin decarbonising the gas distribution network ahead of changes to billing systems and gas thermal energy regulations. As a result, we intend to incorporate this option within the FBM consultation and will propose this as a potential first step, so re-ordering proposed options, summarised as follows:

Option 1 – Work within existing frameworks

Opportunities –

- Begin decarbonisation of gas distribution networks without immediate need for changes to billing or regulations
- This option could stimulate Hydrogen production by blending significant volumes at strategic locations while maintaining FWACV.
- If hydrogen blends could account for the "Majority energy flow" into the LDZ, this would automatically enable reduction / elimination of propane-enrichment of low-CV biomethane supplies, as LDZ FWACV reduced

Challenges –

- Would require gas quality monitoring and control to ensue FWACV cap is not triggered, limiting the blend percentage of hydrogen in the early days.

Option 2 – Embedded Zone Charging (aka FBM "Pragmatic")

Opportunities –

- Could enable cost-saving and carbon abatement from removal of propane-enrichment of low-CV embedded hydrogen or biomethane supplies where network setting makes this feasible
- Would align with development of LDZ-wide network modelling for fully modelled CV for billing
- Could work for embedded low-CV supplies in LDZs alongside "work within existing frameworks"

Challenges –

- Limited to specific embedded or minority flow supplies into the LDZ
- Potentially complex model development, set-up, and operation including some level of process automation – potentially requiring daily reconfiguration of the embedded low-CV billing zones in a dynamic network setting

- Would require a move to meter-point-specific CV and corresponding changes to central and Shipper/Supplier billing systems, processes, and data flows[2]
- Would require a full CV modelling validation in a diverse-CV network setting, with the required derogation from regulations
- Would require amendment to GCoTER to permit/regulate the use of network modelling to create embedded charging areas within LDZs
- Potentially complex changes required to GEMINI system and Section F of UNC Offtake arrangements document, as definition of charging areas would move from LDZ to a dynamic arrangement to accommodate new embedded entry connections
- Changes would be required to UNC around CV data file formats and flows (no changes to LDZ charging methodology and LDZ could be maintained whole for quantification of unidentified gas (UIG), demand estimation, energy balancing and other purposes).

Option 3 – Modelled CV (aka FBM Option 4 – Fully modelled CV)

Opportunities –

- Could provide one consistent methodology for attributing gas CV for billing across the range of potential gas transition scenarios, including hydrogen blending both on "minority energy flow" and "majority energy flow" bases, together with biomethane.
- If proved robust, this approach could present an improved attribution of billable energy to customers, reducing the level of cross-subsidy experienced under the existing LDZ FWACV regime.

Challenges –

- Highly complex model development, set-up, and operation including high levels of process automation and intensive data processing – very likely requiring daily reconfiguration of the charging areas within the LDZ in a dynamic network setting
- Would require a move to meter-point-specific CV and corresponding changes to central and Shipper/Supplier billing systems, processes, and data flows
- Would require detailed feasibility study and full CV modelling validation in a diverse-CV network setting, with the required derogation from regulations, together with a level of on-going verification via strategically placed CV measurement within the LDZ network
- Would require amendment to GCoTER to permit/regulate the use of network modelling to create embedded charging areas within LDZs
- Changes required to GEMINI system and Section F of UNC Offtake arrangements document - charging areas could be defined as "the relevant system node", as CV would be attributed at nodal level across the entire LDZ network
- Changes would be required to UNC around CV data file formats and flows (no changes to LDZ charging methodology and LDZ could be maintained whole for quantification of unidentified gas (UIG), demand estimation, energy balancing and other purposes).

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[2] Except potentially for physically discrete single-fed sub-networks, which could be physically separated from the parent LDZ for CV attribution by inserting a CVDD on the in-feed pipe.

Options in summary

Any change to support the more specific attribution of gas CV to customer metered volumes in a diverse-CV gas transition scenario (other than for physically discrete single-fed sub-networks, as above) will require complex system development, changes to central and client billing systems and CV data flows to support meter-point specific CV for billing, together with enabling amendments to the gas thermal energy regulations both to allow network modelling to be used to configure sub-LDZ charging areas, and to attribute modelled CV for billing.

With the necessary GSMR approvals and system control features in place, remaining within the current frameworks could enable hydrogen blending and initiate gas network decarbonisation, either as the ultimate solution or to buy time for the more complex changes required to support a diverse-CV gas transitional phase.

Ultimately, 100% hydrogen networks would step over these complex requirements, given that the CV of hydrogen is a consistent value[3].

External view of FBM installation at a gas governor station

[3] The CV of hydrogen is 12.1 megajoules per cubic metre (MJ/m^3).

3. Business Case Update

Supporting the Government's Ten Point Plan

The UK Government's Ten Point Plan for a Green Industrial Revolution was released in November last year. Point Two in this plan sets out a vision for driving the growth of low carbon hydrogen. A zonal CV billing framework such as that being explored by the FBM project will be pivotal to enabling the increased uptake of renewable-source or "green" gases, such as biomethane, and could also be vital to facilitating full implementation of hydrogen blending and other hydrogen initiatives. As such, Cadent regards the FBM Project as a potential key enabler to delivery of the government's commitment to achieve net zero. The government document can be accessed here: https://www.gov.uk/government/publications/the-ten-point-plan-for-a-green-industrial-revolution

Supporting the UK Hydrogen Strategy

Published in August 2021, the UK Hydrogen Strategy sets out the Government's road map to drive progress in the 2020s to deliver the 5GW production ambition by 2030 and position hydrogen to help meet the Government's Sixth Carbon Budget (CB6) and net zero commitments. Analysis by BEIS for CB6 suggests 250-460TWh of hydrogen could be needed by 2050, accounting for 20-35 per cent of UK final energy consumption. The government document can be accessed here:

https://www.gov.uk/government/publications/uk-hydrogen-strategy

Following on from the completion of the field trial, the FBM Project has developed a further, comprehensive option for billing reform and has incorporated an option for green gas blending to enable the initiation of gas decarbonisation ahead of the more complex changes to billing systems and regulations that would be required to reform gas billing to support a diverse-CV gas supply transition and switch to full hydrogen, where feasible.

FBM Project CBA

The first annual Project Progress Report in December 2017 provided details of the initial Cost-Benefit Analysis (CBA) undertaken as part of Phase 1 of the FBM Project. The Project CBA will be updated for the industry consultation planned for Q1 2022 and completed for the final Project Recommendations, to be submitted under SDRC 9.5 at the end of the quarter.

Internal view of the FBM instrument array at a gas governor

4. Progress against Plan

The Future Billing Methodology Project is now in its final outputs phase, with the field trial having been completed at the end of March 2021 and measurement sites now in the process of being decommissioned.

The delays experienced in delivering the field trial and the complexity of the subject area, together with further work in reshaping and reprioritising the future billing options have resulted in a number of extensions to the original project schedule.

The final technical output, the MS13 Report on Novel Validation of Network Modelling for Embedded and Network Charging Areas is in the process of being published as this progress report is being finalised.

A consultation document on the proposed future billing options, as described in Section 2 of this report, accompanied by an updated CBA, will be published on 24th January 2022, for responses by 18th February. A number of on-line workshops are being timetabled within the consultation window for the range of gas industry participants.

The final output report under SDRC 9.5 will be released by 31st March 2022 and will contain collated industry responses, recommendations for next steps, a final billing options CBA and a road map for implementation of the recommended option(s).

5. Progress against Budget

Table 5-1 reports the position against the project budget in GBP as at end of October 2021.

TOTAL PROJECT	ACTUAL	BUDGET	VARIANCE	VAR %
LABOUR	2,435,033	2,402,076	-32,957	1.4%
CONTRACTORS / EQUIPMENT	2,650,663	2,680,448	29,785	-1.1%
IT	44,458	62,801	18,343	-29.2%
IPR COSTS	-	-	-	
TRAVEL AND EXPENSES	8,030	28,500	20,470	-71.8%
CONTINGENCY	-	-	-	
DECOMMISSIONING	31,397	206,976	175,580	-84.8%
TOTALS	**5,169,581**	**5,380,801**	**211,220**	**-3.9%**

Table 5-1: Actual costs v budget to P7 2019-20 and v total project budget

Commentary

The Future Billing Methodology Project is now in its final outputs phase, with the field trial having been completed at the end of March 2021 and measurement sites now in the process of being decommissioned.

FBM Flow transducer (upper centre) installed on gas governor regulator plate

6. Project Bank Account

Arrangements are in hand to provide Ofgem with Project Bank statements, in line with Section 8.15 of the Gas Network Innovation Competition Governance Document. Due to the confidential nature of the project bank statements, they have not been included in this report.

Gas PT equipment being calibrated for FBM smart meter trial

7. Successful Delivery Reward Criteria

Table 7-1 below sets out the project Successful Delivery Reward Criteria (SDRC), each under a subsection labelled 9.1 to 9.5. The SDRC are 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. All SDRC delivery dates refer to the end of the calendar month. The delivery dates for future SDRCs have been adjusted to reflect the revised Project Direction provided to Ofgem.

Successful Delivery Reward Criterion	Evidence
9.1a. Industry Engagement – Phase 1 **11 August 2017** **ACHIEVED**	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. Submit Phase 1 report to Ofgem in line with condition 2 set out in section 3 of this Project Direction. Do not proceed on to the remaining SDRC until Ofgem consent is given in line with condition 2.
9.1b. Industry Engagement – Phase 2 **31 March 2018** **ACHIEVED**	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.
9.2. Novel tracking of unconventional gases by measurement **31 December 2020** **ACHIEVED**	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 of the Full Submission.

9.3. Report on novel validation of network modelling for embedded and network charging areas **Extended to 31 October 2021** **Final report 21st Oct marked as public 2nd Nov 2021**	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 in the Full Submission.
9.4. Report on Smart Metering Laboratory Trials **Extended to 31 March 2021** **Published 1st March 2021**	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 of the Full Submission.
9.5. Future Billing Methodology Recommendation **Further extension to complete by 31 March 2022**	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 of the Full Submission.

Table 7-1 Successful Delivery Reward Criteria reflecting amended delivery dates.

8. Data Access Details

All project information, including project submissions, reports, project findings and analysis has and will be published on the FBM Project web site, which can be accessed using the following link: https://futurebillingmethodology.co.uk/

The web site has a web feed facility (RSS) that has been taken up by over 160 individual stakeholders and as we progress with the project, we are seeking opportunities to widen the web site readership, especially among key stakeholders who would be directly impacted by implementation of FBM. The web site is maintained annually and updated at each reporting stage.

However, we will also be utilising a range of existing industry channels such as the UNC Workstreams, ENA and IGEM to actively share project findings.

FBM smart meter trial lab rig at Loughborough

9. Learning Outcomes

The learning outcomes from the Future Billing Methodology (FBM) Project are set out in summary in Section 2 of this report, but can be distilled as shown in the table below:

1. Existing smart gas meters have been demonstrated to have the capability, in principle, to receive a measured CV and convert metered gas volumes to an energy (kWh) value for billing at the point of use. However, in practice, this would require uprated batteries and other specification to perform this role on a systematic basis. In addition, moving to smart meter billing at the point of use would require very significant changes to industry codes, billing systems and data flows, which would need to be assessed separately.
2. The main FBM field trials have demonstrated via the novel use of molecular oxygen tracking, that network modelling can reliably simulate the travel and mixing of gases and so could define charging areas within the LDZ for gases of differing CV.
3. Gas thermal energy regulations (GCoTER) do not permit the use of network modelling to configure charging areas within the LDZ and so would require amendment to facilitate such an approach.
4. The application in practice of network modelling to define charging areas and attribute gas CV would require a full validation of CV modelling to overcome the unavoidable constraint placed upon the FBM field trials in needing to use oxygen sensors to track biomethane, as switching off propane enrichment of biomethane would trigger the LDZ FWACV cap.
5. Future billing options to attribute CV for billing more in line with customers' actual physical gas supply would require: a. changes to regulations, as above, together with b. further complex development/integration of network models, c. significant changes to central and client billing systems to handle meter point specific CV and associated data flows
6. Separating out physically discrete single-fed sub-networks with a CVDD on the feed-in pipe would be permitted under thermal energy regulations but would still require potentially significant billing systems changes to support these separate charging areas.
7. With existing technology, the installation of CV measurement at scale within gas distribution networks would be unsupportable due to capital costs, together with costs of power, maintenance, replacement, and the need to vent sampled gas to the atmosphere, which would also carry a significant carbon cost and be counter to the aims of decarbonisation. Hence options which require this approach is not recommended.
8. Some level of strategically placed CV measurement would be required to provide verification support to a fully modelled CV billing approach, potentially with new compact, non-venting technology.
9. Remaining within the existing framework would still allow for blending green gases such as hydrogen and biomethane, which would provide a route to begin decarbonising gas distribution grids, with minimal change to industry systems and codes.
10. The ultimate switch to 100% hydrogen, where feasible, could be made within the existing GCoTER, although changes to billing systems similar to (6) could be required to facilitate separate hydrogen networks.

10. Intellectual Property Rights

The Project team will comply with the default IPR Provisions. The purpose of the project has been to provide a proof-of-concept for 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, but not limited to 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.

11. Risk Management

The FBM Project field trial has now been completed and the field trial measurement sites are in the process of decommissioning. The same rigorous design process, safety management and Streetworks processes are being applied to the isolation, deconstruction and removal of gas analysis instrumentation and temporary street furniture, as applied in the construction phase.

12. Accuracy assurance Statement

This report has been prepared in accordance with the Gas Network Innovation Competition Governance Document published by Ofgem. The project has been subject to review and challenge by the Cadent Project Manager and signed off by Damien Hawke, Future Networks Manager, who is Project Sponsor for this NIC project.

Damien Hawke has confirmed that the processes in place and steps taken to prepare this Project Progress Report are sufficiently robust, and that the information provided is accurate and complete.

13. Glossary of Terms

Term	Meaning
CBA	Cost-Benefit Analysis
CV	Calorific Value – expressed in mega Joules per cubic metre of gas (mJ/m^3) at standard temperature and pressure
CVDD	Calorific Value Determination Device (a gas calorimeter or approved alternative)
DNO	(Electricity) Distribution Network Owner
DNV	Project partner of Cadent
EA	The LDZ known as East Anglia
EM	The LDZ known as East Midlands
ENA	Energy Networks Association
FAT	Factory Acceptance Testing
FBM	Future Billing Methodology
FWACV	Flow Weighted Average Calorific Value
GB	Great Britain
GCoTER	The Gas Calculation of Thermal Energy Regulations
GDN	Gas Distribution Network
GS(M)R	Gas Safety (Management) Regulations – governs the safety of the GB gas supply
IGEM	Institute of Gas Engineers and Managers
LDZ	Local Distribution Zone (gas distribution networks in GB comprise 13 LDZs)
LTS	Local Transmission System – the highest-pressure tier of the gas distribution system in each Local Distribution Zone
NIC	Network Innovation Competition
RTU	Remote Telemetry Unit
SAT	Site Acceptance Testing
SDRC	Successful Delivery Reward Criteria
UMS	Unmetered (electricity) Supply

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