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Xoserve

Consultation pre-read document

Gas billing for a greener future:
Maintaining fair billing during the transition to net zero

December 2021

Glossary

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BEIS - the Department for Business, Energy and Industrial Strategy, this is the Government department responsible for energy policy.

Calorific Value (CV) - the energy content produced when gas burns. This differs depending on the type of gas, e.g. hydrogen has a different energy content, or calorific value, than natural gas.

Flow weighted average CV (FWACV) - a calculation used today to determine the average calorific value within an LDZ for charging purposes.

Future Billing Methodology (FBM) - a specific project that was operated by Cadent and DNV to investigate the ability to define/measure the CV in discrete parts of the network for billing purposes - the results of these trials are incorporated within this consultation document.

Gas Calculation of Thermal Energy Regulations (GCoTER) - regulations governing the process of calculating energy content, or calorific value, that is used for calculating gas bills in Great Britain.

Gas Distribution Networks (GDN) - the four main companies responsible for the regional gas system infrastructure. They are: Cadent, Northern Gas Network (NGN), Southern Gas Network (SGN) and Wales & West.

Gas Safety Management Regulations (GSMR) - the rules and regulations in place in the UK governing the composition of our gas supply to ensure it remains safe to use.

Hydrogen blend - the blending of up to 20% hydrogen into natural gas.

Hydrogen strategy - Government's strategy to support a thriving hydrogen economy in the UK

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

Independent Gas Transporter (IGT) - companies which own and operate independent gas networks, typically connected to the regional gas networks and often supplying new build housing, or specific commercial gas customer sites.

Local Distribution Zone (LDZ) - regional gas distribution networks, of which there are 13 in GB, operated by four Gas Distribution Networks.

National Transmission System (NTS) - the high-pressure transmission network operated by National Grid. This is the part of the gas network that transports gas from the gas terminals to LDZs or IGTs.

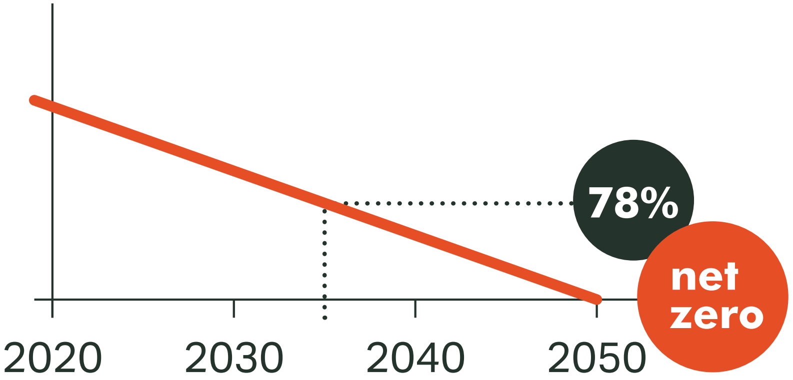
NTS/LDZ Offtake - the point at which gas passes from the NTS into the LDZ system.

Ofgem - the Office of Gas and Electricity Markets, Ofgem is the regulator for the energy strategy.

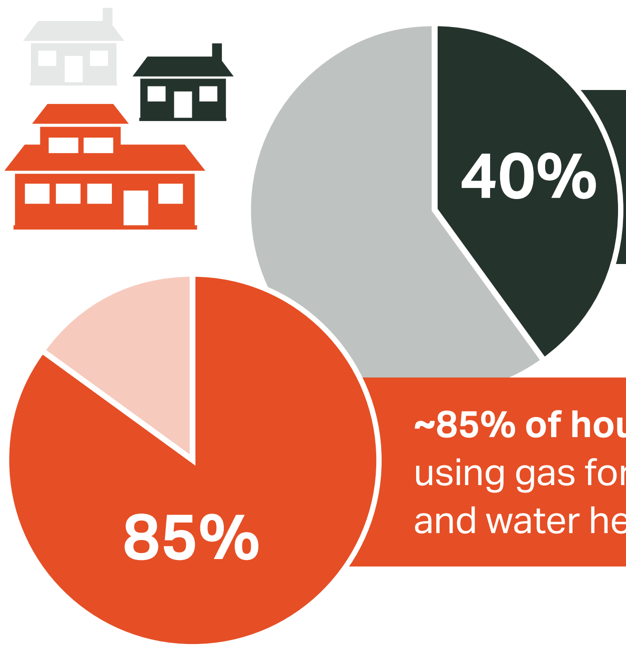
Ten point plan - the Government's proposed plan for accelerating the path to net zero by 2050

https://www.gov.uk/government/publications/the-ten-point-plan-for-a-green-industrial-revolution

Industry context



The UK Government has legally committed to achieving **net zero by 2050** and is expected to further commit to achieving **78% of this by 2035**.



Heat accounts for **~40% of UK emissions**

~85% of households using gas for space and water heating

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Gas networks in Great Britain supply

23 MILLION customers

24/7 with virtually no interruption.

To decarbonise heat both at the scale and rate required, we must begin to decarbonise Great Britain's gas networks

Starting this transition will require maximising the use of **renewable-source gases** such as biomethane and introducing hydrogen-methane blends, both of which have a lower carbon and energy content than natural gas, and with the ultimate aim of distributing **100% hydrogen** where practicable.

But there's a problem we need to overcome first...

The current billing methodology **doesn't allow for varying calorific values.**

Transitioning to greener gas

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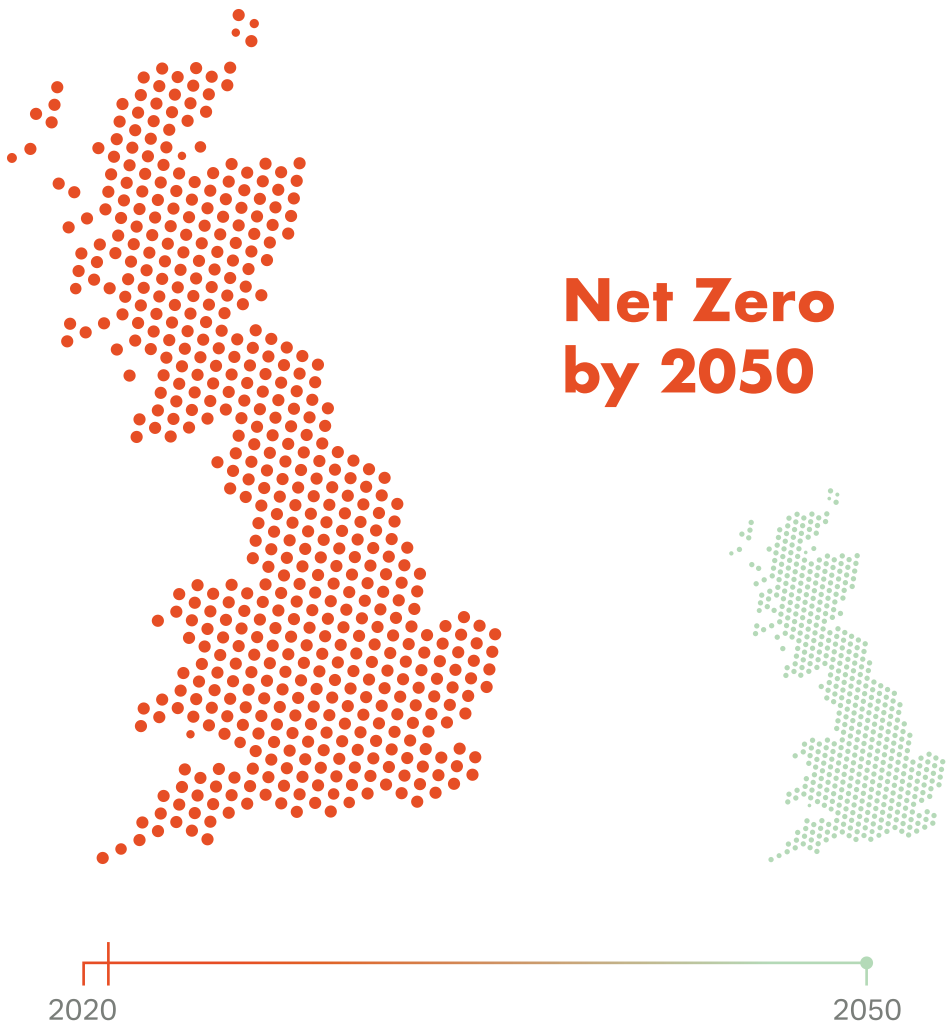
The UK's target of reaching net zero emissions by 2050 is an ambitious one, and to reach it will require significant changes to be made across every section of society. As we move towards a net zero future, we must think not only about what we will need to do to get there, but also about how we can make the transition as smooth as possible for businesses and individuals.

At Cadent, we're focused on how we will need to change the way that we heat homes and businesses across the UK. Today, most of our buildings have traditional central heating and hot water systems, which means that the bulk of our heating and hot water demand in buildings is met by natural gas. To ensure that the UK can meet its net zero target, we will therefore need to find greener alternatives to natural gas for heating our commercial and residential buildings.

The final solution to heating UK homes is as yet unresolved, however it is likely to include a range of alternatives, including heat pumps and hydrogen boilers. For instance, 600,000 heat pumps are planned to be installed per year by 2028 and Government plan to consult on mandating hydrogen-ready boilers from 2026.



Transitioning to greener gas

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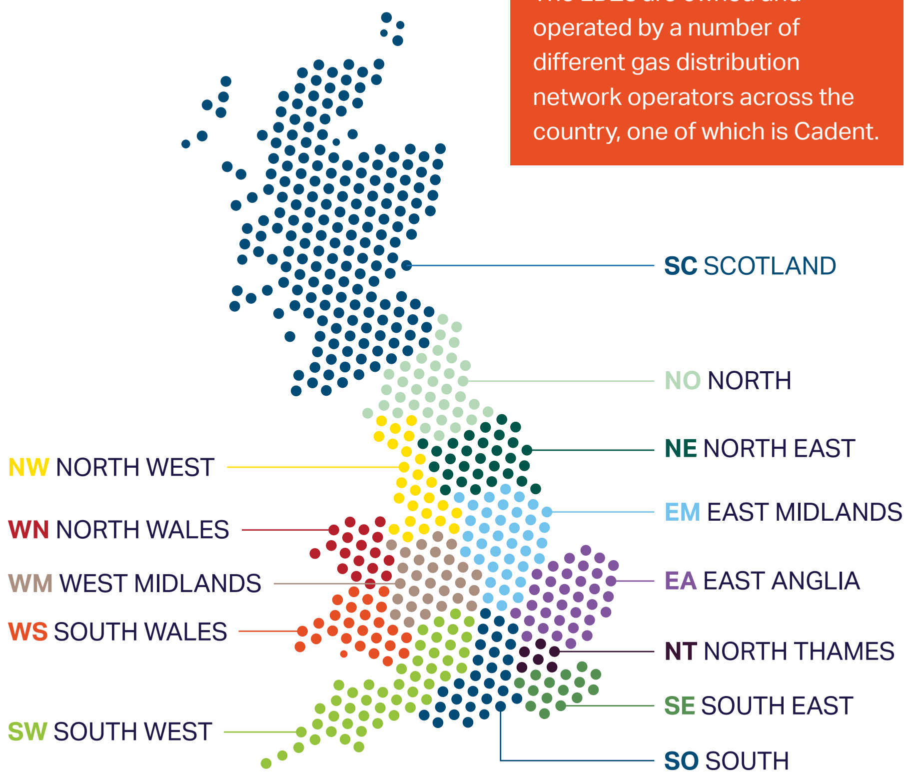
The race to decarbonise heating is already well underway. Electrification is set to play a key role in reducing our heating emissions, as many low-carbon heating technologies like heat pumps and modern storage heaters are powered by electricity. But we cannot rely on electrification alone, as switching all our homes and businesses to electric heating, while increasingly electrifying other areas like transportation at the same time, will put significant pressure on our electricity grid. Not only that, heat pumps may not be suitable for all types of property, whereas hydrogen can offer a low disruption solution to heating homes. Gas will therefore continue to have a key role to play within our energy system for the foreseeable future, but we will need to shift to greener gases to ensure that we can meet demand while also meeting our sustainability targets.

Earlier this year the Government published its Hydrogen Strategy, which focuses on how the UK will quickly develop a low carbon hydrogen market, including an ambition of 5GW low carbon hydrogen production by 2030, and the ability to blend hydrogen in the gas network by 2023. Hydrogen blending remains a firm part of the decarbonisation debate, with a number of exploratory projects currently being funded across the UK, offering a way to begin the decarbonisation of heat with minimal consumer impact. Projects such as HyDeploy and Future Grid demonstrate that hydrogen blends of up to 20% in natural gas can be safely transported and used in our existing pipes and appliances. A 100% hydrogen neighbourhood is targeted to be in place in 2023, followed by a village in 2025 and town by 2030.

A number of biomethane assets are already providing greener gas in some areas across the UK. There are currently around 100 biomethane sites injecting into the grid. With the government's recently launched 'green gas support scheme', and a target set to achieve 20TWh of biomethane injected per annum by 2030, this sector is set for continued growth.

The LDZs are owned and operated by a number of different gas distribution network operators across the country, one of which is Cadent.



Our evolving gas system

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2020
Boris Johnson's Ten Point Plan includes a £240 million Net Zero Hydrogen Fund; £81 million allocated to hydrogen heating trials in the Spending Review.

2022
Government intends to finalise hydrogen business models.

BEIS value for money assessment on blending due.

Billing methodology decision needed

2023
The Government will begin hydrogen heating trials in a local neighbourhood.

10 point policy plan objective for hydrogen blending.

BEIS policy decision expected on blending.

2025
Our target for reaching 1 GW of hydrogen production capacity; large village hydrogen heating trial set to go live.

2030
Biomethane target of 20TWh by 2030

2030
The Government is aiming for a pilot hydrogen town.

2050
UK'S NET ZERO TARGET

2020 — 2050

As an industry we must have confidence that we are able to bill blended hydrogen in a cost effective way during 2022 in order to support a positive policy decision the following year.

Objectives

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With substantial environmental targets on the horizon, uncertainty as to the funding available long-term and no one clear path to a greener gas future, Cadent is looking to bring gas industry partners together to:

- Open the debate around how billing could be approached as hydrogen and biomethane are introduced at larger scale into the gas networks
- Identify the impacts across industry parties of a variable calorific value
- Identify possible solutions to managing data flows in such a way that consumer billing is clear, effective and fair during a transition to green
- Estimate costs/ implementation timescales of those options such that recommendations can be formed
- Discount any options that are currently prohibitive either in terms of costs, compliance, implementation timescales or a combination of all

Assumptions

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- For hydrogen blending, GSMR will accommodate up to 20% hydrogen
- Assume all existing meters can work with up to 20% hydrogen blend
- Current decision timelines will be met
- Hydrogen will be recognised in industry codes

A note on the regulatory framework

Background & context

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There are two main regulations around gas composition and how gas energy is quantified for billing purposes that could be problematic as we begin to blend hydrogen and biomethane into mainstream supply. They are...

The Gas Safety Management Regulations

To ensure that gas is safe for use in customers' homes, there are rules and regulations around the composition of our gas supply. The existing regulations were established for a system powered entirely by natural gas, although an exemption has been introduced to allow a higher oxygen content for biomethane. Further exemptions have also been put in place to allow up to 20% hydrogen content in areas where hydrogen blending trials are taking place, but this is on a project by project basis rather than at scale.

It would be possible to transition to a point where hydrogen blending becomes a systematic part of gas distribution under current regulations. This would need to be underpinned by HSE review and support to allow widescale blending of up to 20%.

The Gas Calculation of Thermal Energy Regulations

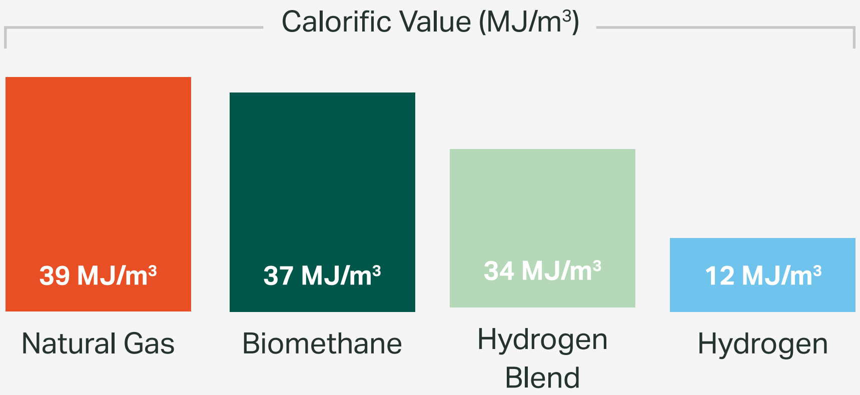
There are also regulations around the process for determining the energy content - or calorific value (CV) - of gas entering the network. This is important as calorific value is used within customer billing calculations. Gas transporters calculate the flow-weighted average CV in a given charging area in order to bill customers fairly. These regulations limit the allowed value for the billing CV to 1MJ/m^3 above the lowest CV in that zone. This is to ensure that consumer bills are fair and equitable and remove the risk of disproportionately high bills.

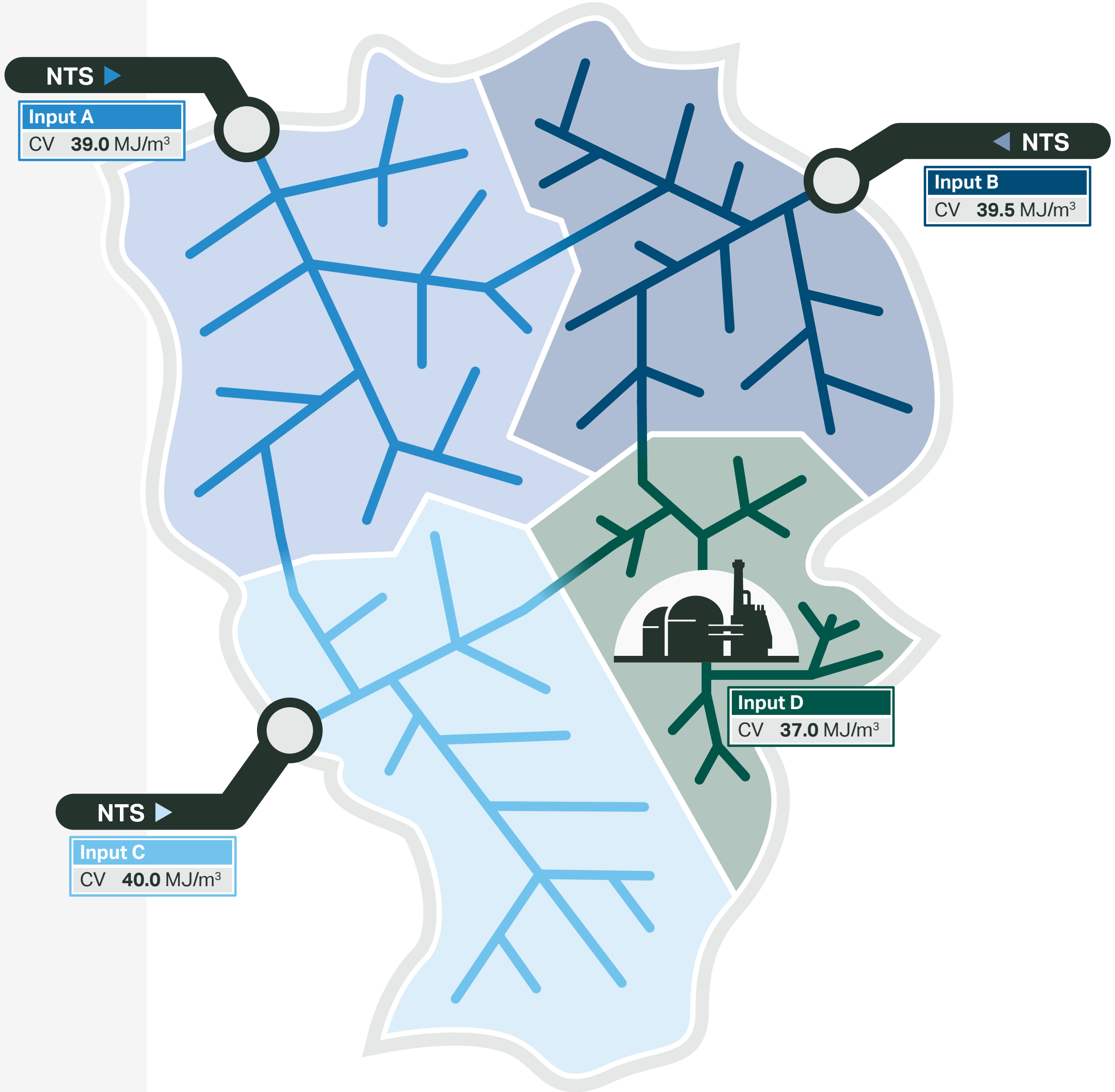
Today, propane is added to biomethane to raise the CV to within the 1MJ/m^3 cap. This raises its carbon load - an action that negates the positive impact of decarbonising the gas, but one that is necessary to adhere to the regulations.

The calorific value challenge

While we investigate different concept-level options for decarbonising heat, we must consider the wider implications that any changes we make will have on the gas industry and the customers we serve.

One of the major challenges of transitioning to a variable gas mix is the impact of a differing energy content (or calorific value) for natural gas, biomethane and hydrogen. Today, our entire supply has a calorific value (CV) of around 39 MJ/m^3, while biomethane has a CV of around 37 MJ/m^3 and hydrogen has a CV of just 12 MJ/m^3. Customers using lower-CV gases would use a proportionately greater volume to meet the same energy requirement.





Simplified LDZ Example

The calorific value challenge

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As we transition to Net Zero, we will encounter a scenario whereby customers will receive different gas blends - whether that's biomethane or up to 20% hydrogen blend - before a possible switch to 100% hydrogen (where feasible). Where gases of different calorific values share the same network, a new methodology may be required to apply the appropriate CV for billing purposes - reflecting energy usage - ensuring that customer bills remain fair and equitable in the face of a changing gas mix. Ideally, this should be managed without billing reform and in compliance with current regulations. Pure hydrogen would operate using a separate network, or a repurposed network.

At present, supplying a different gas mix to different customers in the same local distribution zone (LDZ) could contravene Gas (Calculation of Thermal Energy) Regulations, which contain a flow-weighted average cap that only allows for a variation of 1MJ/m3 above the lowest calorific value within any LDZ. These rules mean that any embedded methane that is currently added to our gas supply must be mixed with propane to ensure that the overall calorific value of the supply remains within the allowed limits. Propane actually contains three times the carbon of natural gas and is fossil-based, so while the current approach is necessary to adhere to existing regulations, they presently counteract the positive environmental impact of biomethane.

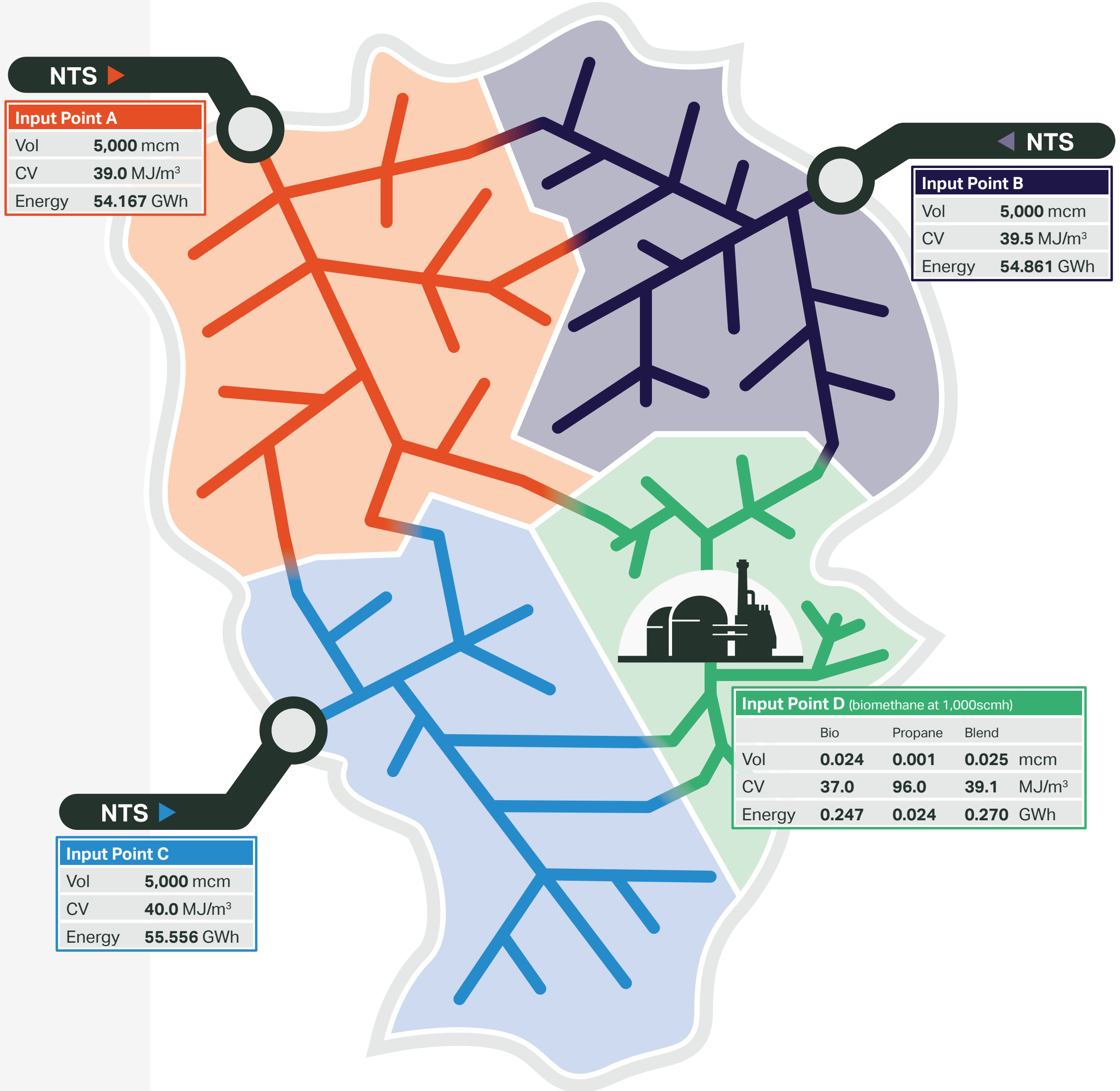

Diagram demonstrates the propanation of biomethane required to remain within the flow-weighted average cap within an LDZ, shown at Input Point D. This is necessary within current regulations.

The calorific value challenge

Biomethane is already being injected into our gas supply via embedded plants, and (subject to the necessary changes to gas safety regulations) it won't be long before hydrogen blends move beyond trials and begin to affect more customers across the country. So we need to find a solution that will ensure that all customers are billed fairly, and that rules and regulations are fit for our changing gas system, sooner rather than later.

Cost calculations

All UK gas users are billed in kWh terms. All but the very largest customers are metered purely in volume terms (because CV measurement kit is bulky and very expensive) and the calorific value of the gas is applied separately, using a flow-weighted average CV for their LDZ. This CV value is combined with their metered volume to provide the billable kWh usage.

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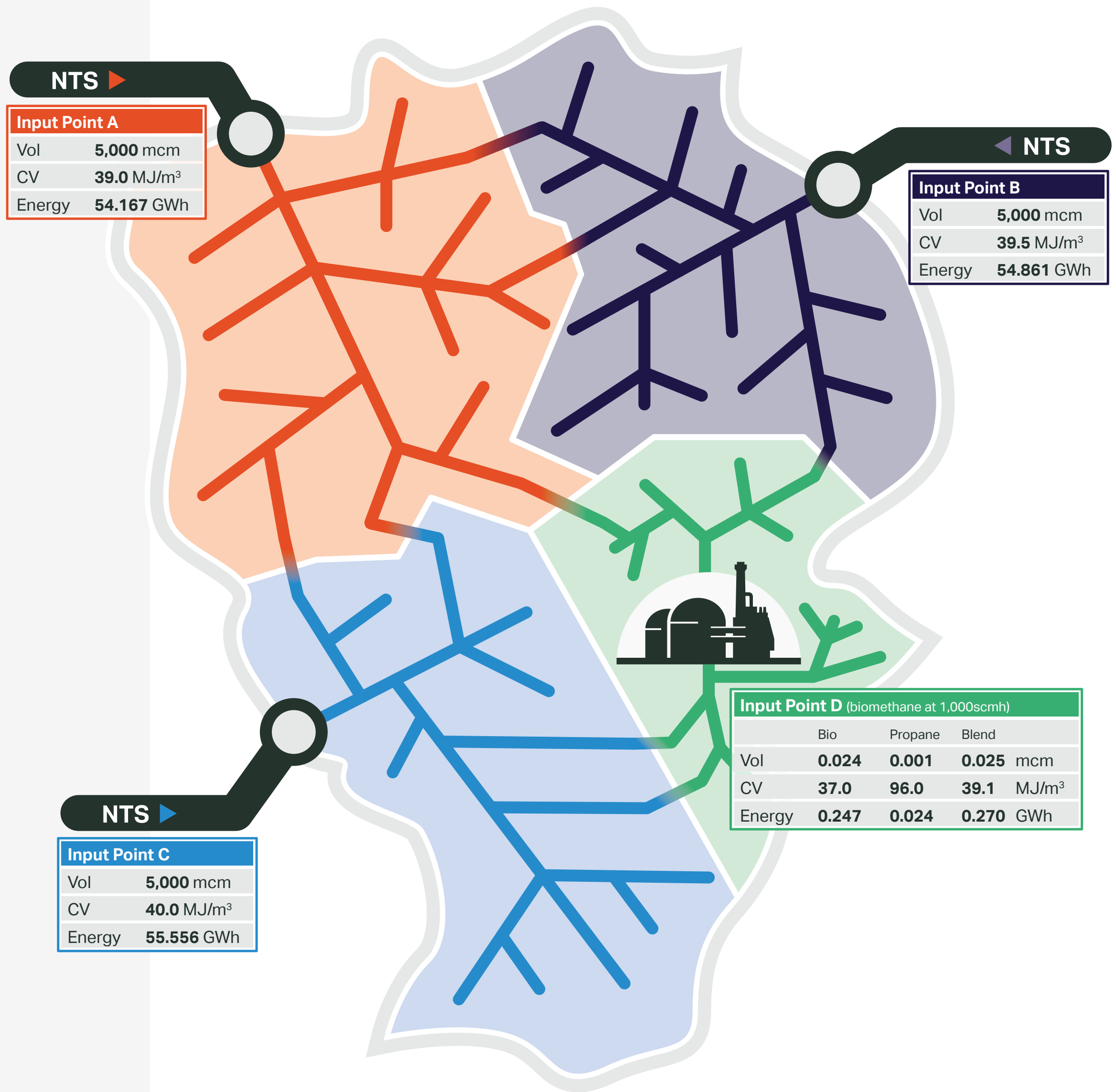

Simplified LDZ Example

Potential solutions

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At Cadent, we're keen to ensure that we take the best route to a greener gas future for everyone, so we have carefully been considering the challenges ahead and how they might be overcome. These ideas have been discussed within the network community to gauge a high level of consensus.

As a result of our further evaluation of options following publication of the main FBM Project output reports, we have re-ordered our proposed options, which are summarised as follows:

- **Option A: Working within existing framework**
  minimal industry change

  Blending green gases such as hydrogen and biomethane with natural gas in the Local Distribution Zone, within the existing flow-weighted average calorific value framework, as a no-regrets first step towards decarbonising heat.

- **Option B: Embedded Zone Charging**
  (formerly FBM "Pragmatic")

  Isolating LDZ sections with a common gas mix. Using network modelling to create charging zones around embedded low-CV gas supplies within the Local Distribution Zone.

- **Option C: Online CV Modelling**
  (formerly FBM Option 4 – Fully modelled CV)

  Using online network modelling to derive output modelled gas calorific values at meter point level across the Local Distribution Zone.

- **Option D: Zonal CV Measurement**
  (formerly FBM Option 2 "Composite")

  Breaking the Local Distribution Zone down into zonal charging areas with network-embedded CV measurement. Expected costs and timescales make this prohibitive.

- **Option E: Local CV Measurement**
  (formerly FBM Option 3 "Ideal")

  Local CV measurement at system node level throughout the Local Distribution Zone. Also discounted due to very high cost and complexity.

Options considered through field trial

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For the past four years, Cadent and DNV have been working on the design, preparation and execution of field trials, network modelling and analysis as part of our Future Billing Methodology (FBM) programme, which aims to identify and explore potential solutions for the future of gas billing. The field trials sought to physically identify the zone of influence exerted by an embedded biomethane source, observe how it moved and validate network modelling as a reliable means to simulate the travel and mixing of gases within the network under a range of demand conditions. Oxygen tracking was used because the existing thermal energy regs effectively prevent us from stopping enrichment of biomethane to measure CV difference - as this would be deliberately invoking the LDZ FWACV cap.

We used the insight gained from our field trials to re-evaluate the three original project billing options and to inform further thinking on two additional options for “greening” our gas networks towards Net Zero.

Option A

Working Within Existing Framework

How it works

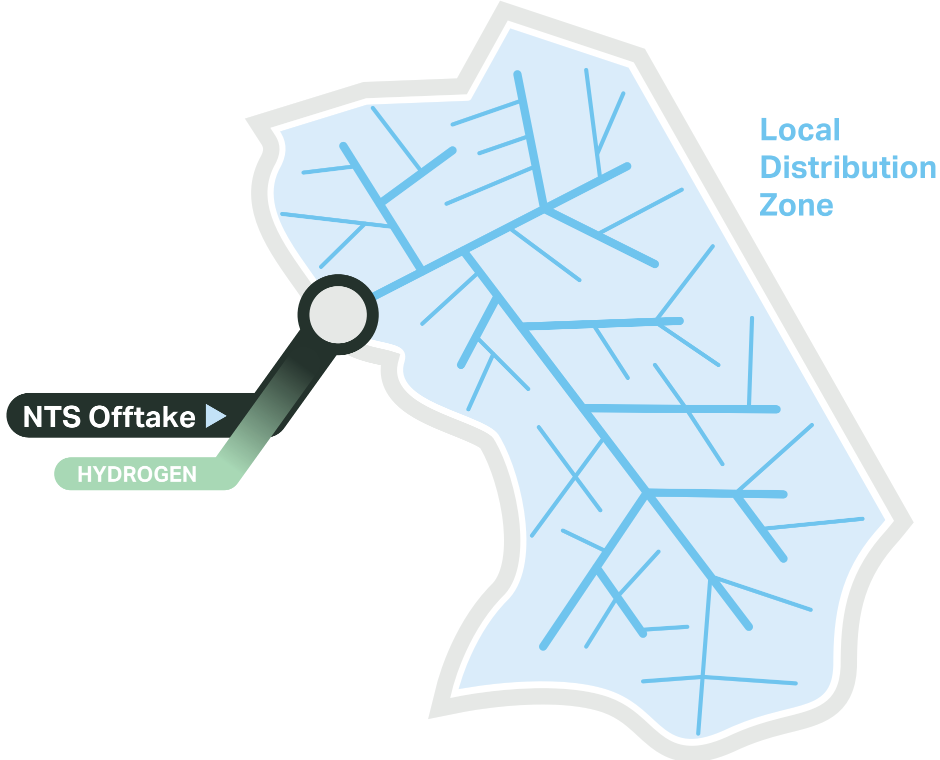
This approach focuses on blending low-carbon gases such as biomethane and hydrogen with the native natural gas in the existing LDZ system, as follows:

Biomethane – Cadent is developing a biomethane blending strategy which could enable future supplies to blend biomethane into native system gas within existing LDZ FWACV limits and so minimise / remove the requirement to add propane, so freeing up the green benefits of this renewable-source gas.

Hydrogen – With the right system controls in place and the necessary HSE approvals, it should be possible to phase-in the blending of hydrogen into the existing gas network within the existing LDZ flow-weighted average CV cap.

The initial phase would take the form of adding a small percentage blend (e.g. up to 5% hydrogen), where the blend remains a "minority flow" into the LDZ. Additional hydrogen supplies could be introduced on this basis, then as the proportion of hydrogen blend in the LDZ system increases, the volumetric hydrogen blend rate could be ramped up within the 20% limit, which is the safe upper limit for existing appliances. Where blends are delivered at higher tiers of the gas network, the same percentage volume of hydrogen represents a much greater carbon abatement impact on the total LDZ network.

Blending in hydrogen in this way could therefore significantly reduce the overall carbon burden of our gas supply without the need for changes to gas thermal energy regulations or billing systems.



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Option A

Working Within Existing Framework

Recommendation: **Least change option**

Potential Opportunities

We believe that the Working within existing framework option represents a significant opportunity for beginning the transition to net zero with the least requirement for regime and system change. It is the closest means of operating an "as is" model from a regulatory perspective.

We estimate that this could be the most cost-effective option for the industry, as it doesn't involve the regulatory changes and systems investment required to support other options.

For biomethane supplies which are unable to blend without enrichment into the LDZ network, hydrogen blending at scale would lower the overall CV in the network, and so reduce or eliminate the requirement to enrich biomethane with propane, freeing-up the green benefits of those supplies.

Whilst hydrogen blending is limited to within a 20% safe blend limit, the impact of wide-scale blending of hydrogen and natural gas could also enable growth of the hydrogen supply market, so providing a secure supply base to transition onwards to full hydrogen networks where feasible and economical.

Where electrification and other non-gas heat energy vectors remain problematic, we believe that hydrogen blending, and hydrogen networks will have a continuing role to play in keeping customers safe and warm.

Potential Challenges

This would require enhanced monitoring and control to ensure the lower CV gas does not trigger the cap, resulting in lower percentages of hydrogen added where hydrogen blend is a 'minority flow' into LDZ, and higher percentages when where hydrogen bend is a 'majority flow'. The solution could work with a blend of up to 20% hydrogen and biomethane with natural gas. Gas network operators would continue to monitor and control the flow-weighted average CV across each LDZ.

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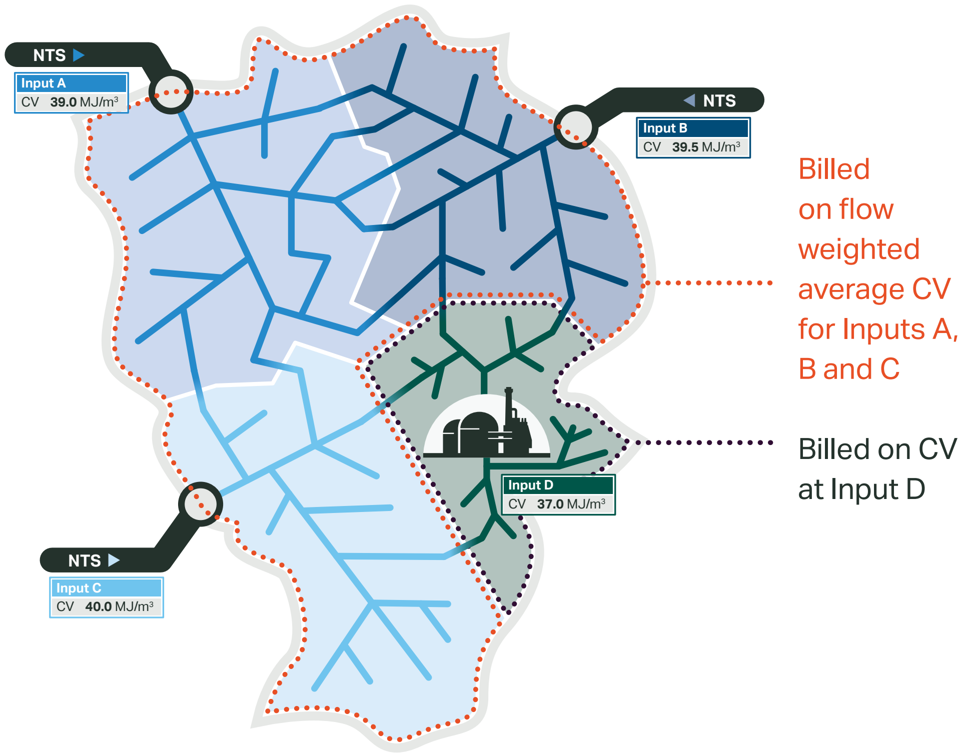
Option B

FBM: Embedded Zone Charging

How it works

This billing option focuses on low-carbon gas sources embedded within the Local Distribution Zone, such as biomethane, which has a lower calorific value (CV) than natural gas. We would use network modelling to identify which customers are connected to the parts of our network that receive low CV gas from these input points, and then bill them based on the CV of their local biomethane supply. Customers outside of this zone would continue to be billed on the flow-weighted average CV of the other inputs to that Local Distribution Zone.

We could either apply a typified bill-impact analysis or use CV modelling at a specific demand level to allocate customers to particular zones for billing purposes.



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Option B

FBM: Embedded Zone Charging

Potential Opportunities

- This option could enable propane cost-saving and carbon abatement by removing the need to fully propane-enrich low-CV embedded hydrogen or biomethane supplies, where network setting makes this feasible.
- Development of this approach would feed into the development of LDZ-wide network CV modelling for Option C – Online CV Modelling.
- Could work for embedded low-CV supplies in LDZs alongside the "work within existing frameworks" option.

Potential challenges

If we choose Embedded Zone Charging, there are some potential challenges for the gas industry, including…

- Our field trials have shown that the zones of influence exerted by gas supplies onto the network fluctuate throughout the day and across different seasons, and that network models can reliably simulate the travel and mixing of gases under those varying demand conditions. However, we will also need to consider how other factors (such as biomethane plant outages for maintenance, nearby industrial gas sites switching on and off, routine and reactive work on the pipeline system etc.) could affect the embedded zone and our billing process.
- Applying a typified bill-impact analysis to allocate customers in or out of the embedded billing zone at scale could be complex to put into practice and we could risk misallocating and overbilling some customers. However, setting the embedded zone too wide would lead to under-billing and unallocated gas energy in the Local Distribution Zone.
- Further work would be required to determine the optimal demand level we should use when modelling the embedded billing zone, and to determine how frequently the zone should be reviewed to ensure customers continue to be billed fairly and consistently, whilst minimising unallocated energy.
- We would need to assess each candidate network with an embedded gas supply source to ensure that this approach is suitable for that network. Where it's not suitable, we will need to continue to propanate low CV gas sources, unless mitigated by other means, such as wide-scale hydrogen blending at NTS/LDZ offtakes.
- This solution will work for the short- to medium-term, but as we begin to blend more diverse gas sources into our supply we will need to enhance our current billing systems to enable daily enable daily attribution of the relevant CV for billing at a meter-point-specific level.
- We believe that this would require changes to the gas thermal energy regulations.

Option C

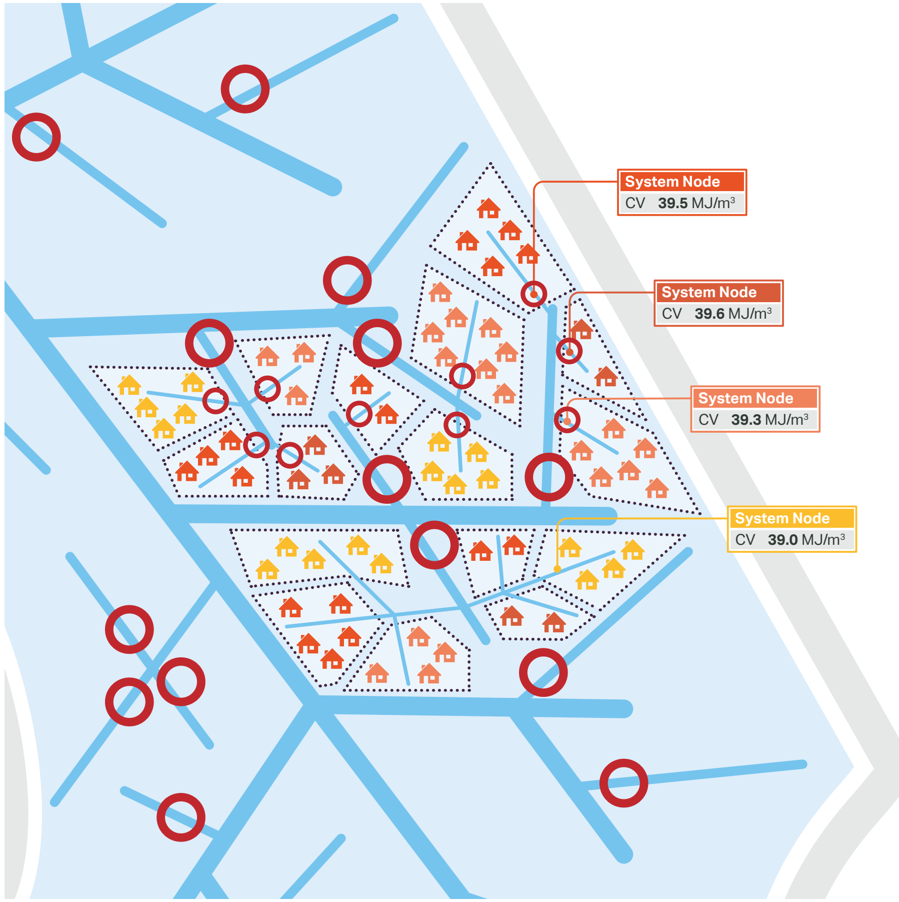
Online CV Modelling

How it works

Online CV Modelling would use measured CV at all system entry points, together with live data from the Local Transmission System to inform detailed modelling of output CV values at each system node.

Daily average CV values for each system node would then be attributed to the meter points attached to the relevant node for billing.

This solution could provide one consistent method for billing in any scenario, whether that is an embedded supply, bulk hydrogen blending at an LDZ entry point, or a combination.



Option C

Online CV Modelling

Potential Opportunities

- This option could provide one consistent methodology for attributing gas CV for billing across the range of potential gas transition scenarios.
- It could enable hydrogen blending on "minority energy flow" basis to be ramped up towards the 20% blending limit and support an evolution to a "majority energy flow" hydrogen blend. It could also enable the universal removal of biomethane enrichment with propane.
- If proved robust, this approach could also present an improved attribution of billable energy to customers, reducing the level of cross-subsidy experienced under the existing LDZ FWACV regime.

Potential challenges

We expect there will be some challenges with our Online CV Modelling solution, such as…

- This option would require the use of additional software, streamlining and automation of certain processes.
- Organisations across the gas industry would need to invest in significant system development to transition from current billing methodologies to the new online cv modelling billing process.
- At present, regulations do not allow for different calorific value models to operate within the same Local Distribution Zone, which means regulations would need to change to make this solution viable.

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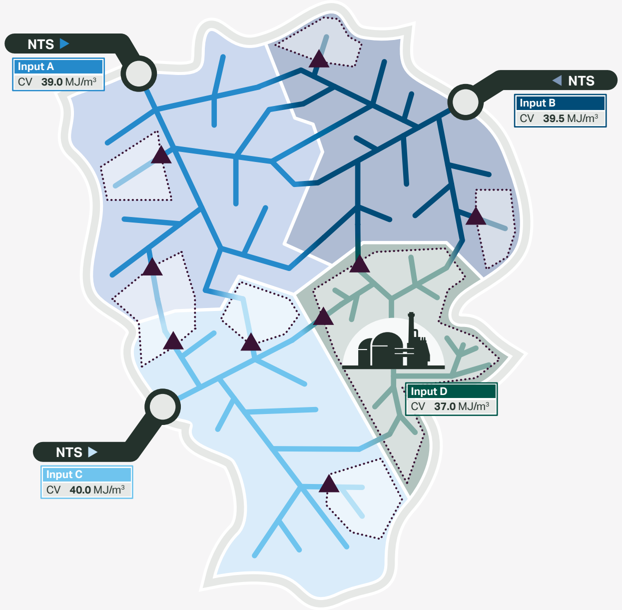
Option D

FBM: Zonal CV Measurement

How it works

This option builds on the methodology behind Embedded Zone Charging and would involve breaking the entire local distribution zone down into virtual charging areas, identified by use of network models. Meter points in each zone would be allocated to a specific calorific value determination device for billing. This approach would require the installation of a moderate to significant number of additional calorific value determination devices within each local distribution zone.



Recommendation: **Discount this option**

Potential challenges

The challenges we foresee in implementing our Zonal CV Measurement solution include…

- This is a logical extension of the relatively simple Embedded Zone Charging Option. Network models would be used to determine how to break the LDZ down into charging areas and each charging area would require one or more CVDDs to drive billing. The cost and complexity of installing, powering, maintaining (including land access rights) and communicating with up to 10,000 extra CVDDs, plus gas venting rates, could be unsupportable in reality without a very significant advance in CVDD technology.
- Existing billing systems would need to be enhanced to enable attribution of the relevant calorific value for billing at a meter-point-specific level.
- As for Embedded Zone Charging, Zonal CV Charging offers a solution to billing based on measured calorific values, but would also bear a complex dependency on physical network configuration, any changes to which would drive corresponding changes to billing zones and CV measurement requirements.
- A further potential limitation of this approach is that where hydrogen blending is deployed, the potential decrease in calorific value of 4–5 MJ/m^3 in parts of the network could make zone configuration and CV measurement arrangements extremely complex.

Note: As part of FBM trials it took 3 years to install 35 measurement sites within the East of England network. Access to land is a major issue, among others.

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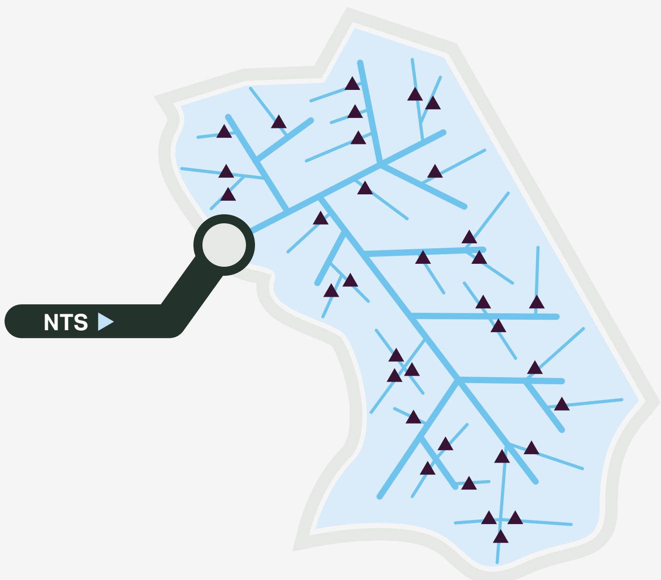
Option E

FBM: Local CV Measurement

How it works

The third option explored by our Future Billing Methodology programme is best described as “Local CV Measurement”. This option is the ultimate logical extension of the other FBM options, and envisaged installing calorific value determination devices at local level throughout the gas distribution network (up to 44,000 in total). It also considered the potential further option to link these devices to customers’ smart meters, as a preparatory step towards full gas energy metering at the point of use. This option would in principle eliminate any element of estimation from the billing process.



Recommendation: Discount this option

Potential challenges

There are a number of significant challenges with our Local CV Measurement option, including…

- Due to the scale and complexity of CV measurement, this option would be unsupportable without a very significant step-change in CV measurement technology.
- Even with the sought-after changes to CV measurement technology, installation, maintenance, power supply (each requiring land access rights) and data communications would still pose very significant challenges
- Auditing, testing and calibration of such a large population of CV measurement devices would require significant time and resources.
- Existing billing systems would need to be enhanced to enable attribution of the relevant calorific value for billing at a meter-point-specific level.

Cost analysis

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Clearly, there are a number of different ways that we can approach the challenge of ensuring that customers are billed fairly as we transition to a greener gas system.

Indicative cost of billing system changes as a result of changed CV attribution process.		Option A Working within existing framework		Option B Embedded Zone Charging		Option C Online CV Modelling		Option D Zonal CV Measurement		Option E Local CV Measurement	
		LOW	HIGH	LOW	HIGH	LOW	HIGH	LOW	HIGH	LOW	HIGH
Capex	£m	0	0	58	162	82	186	395	499	802	906
Opex (Set-up)	£m	0	0	0	0	4	4	1	1	4	4
Opex (On-going)	£m p.a.	0	0	2	2	5	5	7	7	13	13

Next steps: Consultation

We'll be opening an industry consultation on this topic on **31st January 2022**, for responses by **28th February 2022**. We would value input from across the industry on this issue.

Invitations will be issued in early January. In the meantime, if you have any questions please contact:

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