Department for Energy Security & Net Zero

Hydrogen Blending into GB Gas Distribution Networks: Government Response to Consultation

Summary of responses received and government response to consultation on hydrogen blending into GB gas distribution networks

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Any enquiries regarding this publication should be sent to us at: hydrogentransportandstorage@energysecurity.gov.uk.

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General information

Government response structure

In this document we summarise the responses received to each of the 10 questions in our consultation on hydrogen blending into GB gas distribution networks.

The consultation was open from 15 September 2023 to 27 October 2023. We received 129 responses from stakeholders submitted through the consultation page on the government website and via email. We held stakeholder webinars and workshops and had continuous engagement with stakeholders through working groups and bilateral meetings. The government is grateful to those who took the time to respond to our consultation and participate in our stakeholder engagement events.

We are publishing this government response alongside a separate document setting out our strategic policy decision on whether to support hydrogen blending into GB gas distribution networks. The strategic policy decision document also sets out our intended policy positions for the implementation of hydrogen blending into GB gas distribution networks, if enabled by government, and we intend for it to be read alongside this document.

Working with the devolved administrations

The Department for Energy Security and Net Zero intends to work with the Devolved Administrations as we assess the case for hydrogen blending to ensure that any recommended policies take account of devolved responsibilities. Where any proposals are suited to implementation on a UK or GB-wide basis, working with the devolved administrations can help to facilitate the successful deployment of these proposals and consistency with devolved policy.

Analysis of responses received to the consultation

This government response outlines the consultation position, a summary of the responses to the consultation and the government's response, organised under each consultation question.

In summarising the overall responses to each question, we have used a number of terms:

- "Most" or "the majority" indicates over 50% of the responses in question.
- "Many" indicates 25% to 50% of the responses in question.
- "Some" indicates 10% to 25% of the responses in question.
- "A few" indicates less than 10% of the responses in question.

We have thematically analysed each response as a whole based on the themes set out in the consultation and identified via stakeholder engagement. Responses which did not explicitly express their support or disapproval for the specific question were logged but classified as neither supportive nor unsupportive. When summarising responses to the consultation, all accompanying written text was analysed for each question. Where information provided by a respondent related to a different question, we have summarised it under that other question.

Chapter 1 – Introduction

The hydrogen economy and hydrogen blending

Hydrogen can support decarbonisation of the UK economy, particularly in 'hard to electrify' sectors. Hydrogen produced in the UK can create new jobs across the country, and secure greater domestic energy security, lowering our reliance on energy imports. In 2021, the UK government published its first Hydrogen Strategy,[1] which aimed for 5GW of low carbon hydrogen production capacity by 2030 for use across the economy. Building on these proposals, the British Energy Security Strategy committed to doubling this 2030 hydrogen production capacity ambition to up to 10GW, with at least half coming from electrolytic production.

Hydrogen blending refers to the blending of low carbon hydrogen with other gases (primarily natural gas and including biomethane) in pre-existing gas network infrastructure and appliances. Government set out an ambition to reach a strategic policy decision in 2023 on whether to support the blending of up to 20% hydrogen by volume into the GB gas distribution networks. We have been assessing whether there may be value in having hydrogen blending available to support the early development of the hydrogen economy and have been gathering evidence to determine if blending meets the required safety standards, is technically feasible, economic, and supports government's broader strategic and net zero ambitions.

In the previous consultation in 2022 on Hydrogen Transport and Storage Infrastructure we explored the potential strategic role blending could play to support the development of the hydrogen economy.[2]

Hydrogen Blending into GB Gas Distribution Networks Consultation

Government recently consulted (15 September to 27 October 2023) on Hydrogen Blending into GB Gas Distribution Networks to further understand the potential strategic and economic value of blending.[3] The consultation set out our initial assessment of aspects of the commercial, market, technical and billing arrangements that could accommodate blending, should blending be supported and enabled by government. We sought stakeholder views on this assessment of blending, including the economic analysis and whether any complexities and challenges identified in the consultation could be mitigated through careful policy planning and design. We set out what we considered were the lead options to address these, if blending were to be supported and enabled, and sought views on whether the potential implementation options we

[1] https://www.gov.uk/government/publications/uk-hydrogen-strategy
[2] https://www.gov.uk/government/consultations/proposals-for-hydrogen-transport-and-storage-business-models
[3] https://www.gov.uk/government/consultations/hydrogen-blending-into-gb-gas-distribution-networks

have identified are appropriate for stakeholders. The assessment in the consultation was informed using the evidence that had been gathered to date. The consultation noted that further evidence on blending is being gathered and reviewed which may affect the analysis and lead options for implementation that are presented in the consultation.

This document should be read in conjunction with the strategic policy decision on hydrogen blending which has been published at the same time as this document.[4]

[4] https://www.gov.uk/government/publications/hydrogen-blending-in-gb-distribution-networks-strategic-decision

Chapter 2 – Nature and scope of blending policy decision

Question 1 – Safety and usability of hydrogen blends

Consultation position

Industry trials and demonstrations are ongoing to gather evidence on the safety and usability of hydrogen blending of up to 20% by volume for GB gas distribution network infrastructure and connected gas consumers. Once the evidence has been submitted to government, the Department for Energy Security and Net Zero will work closely with the Health and Safety Executive (HSE) to ensure that safety evidence is assessed independently and robustly. In addition to the trials and testing on the safety of blends for industrial users, this consultation sought to gather views and evidence to further understand the potential impact of receiving fixed or variable hydrogen blends of up to 20% hydrogen by volume on industrial users connected to the existing GB gas distribution networks.

Question 1. a)

Do you have any concerns around the safety or usability of hydrogen blends of up to 20% by volume in the GB gas distribution networks?

Summary of stakeholder responses to consultation

Table 1: Stakeholder response summary to Question 1. a)

Response summary	
Yes	45
No	57
Not sure	10
Not answered or unclear	17

Many respondents did not express concerns around the safety or usability of hydrogen blends of up to 20% by volume in the GB gas distribution network. A key reason cited was that stakeholders viewed that rigorous testing has been carried out in the UK through the blending trials, with most of these respondents citing the HyDeploy programme as demonstrating the safety and useability of hydrogen in existing GB gas distribution networks. Conversely, some

respondents cited that there may be some potential safety concerns regarding hydrogen blending which may require further investigation, such as cast iron and high-strength steels. Respondents noted these concerns are being addressed via industry trials and would be subject to the government review of blending safety evidence. It is important to note that not all respondents who stated they did not have any safety concerns did not mean no safety concerns existed, but that these safety concerns would be researched, and risk assessed by government ahead of any potential regulatory and/or legislative changes, subject to any blending decisions. A few respondents also noted that the UK currently operates a safe gas network using flammable natural gas. One respondent highlighted that whilst hydrogen has a different risk profile, the risks of hydrogen may be comparable to natural gas. Some of these respondents expressed no concerns and did not cite a rationale.

Some respondents expressed concerns around the safety or usability of hydrogen blends of up to 20% by volume in the GB gas distribution network. The main concerns cited around the safety of hydrogen blends were due to hydrogen being a small flammable molecule, which may be more likely to leak, increase safety risks and potentially increase nitrous oxide emissions. These respondents cited that this could be a particular issue for locations with a high population density, such as in urban areas. A few respondents also noted that due to the small size of hydrogen molecules, hydrogen may also be more difficult to store and transport as a gas compared to natural gas. Three respondents disagreed with hydrogen blending more generally, without citing safety or usability concerns.

Concerns around safety or usability of hydrogen blends

- **Safety and usability case requires further consideration** was cited by 11 respondents. These respondents cited that further evidence is needed to fully consider the safety case for blending, including the outcomes from ongoing blending safety trials and demonstrations. A few of these respondents also noted that gas turbines connected to the distribution system may require individual assessment.
- **Upgrading of equipment to accommodate hydrogen blending** was cited by 12 respondents. A few of these respondents cited that some equipment may require relatively small upgrades to safely operate using hydrogen blends, including oxygen sensors, burners, and high-pressure measurement systems. One respondent cited that assurance may be needed so that each type of material (e.g. steel, cast iron) has been risk assessed. Gas engines and equipment, which may require upgrades to address any potential operational impacts of hydrogen blends, were cited by five respondents. One respondent raised safety concerns around the impacts of hydrogen blends on current gas pipelines.
- **Health risks associated with burning hydrogen in boilers** was cited by 5 respondents, who cited that hydrogen blending may lead to the increased production of nitrogen oxide which can be harmful to lungs.
- **Concerns about use of hydrogen for blending more generally** were also cited by 4 respondents. One respondent cited concerns around Carbon Capture, Usage and Storage (CCUS)-enabled production of hydrogen from fossil fuels as an alternative to

electrolytic hydrogen production; another respondent was concerned around the availability of sustainable water required for electrolytic hydrogen production. One respondent cited concerns around the preparedness of the HSE's approved competency training scheme to handle hydrogen blends.

Question 1. b)

If so, is this dependent on whether the blend is a fixed or variable percentage (up to 20% by volume)?

Summary of stakeholder responses to consultation

Table 2: Stakeholder response summary to Question 1. b)

Response summary	
Yes	30
No	35
Not sure	13
Not answered or unclear	51

Dependency on whether the blend is a fixed or variable percentage

Key rationales sighted by those respondents who responded 'no'

- **Evidence from the trials do not suggest concerns** was cited by 9 respondents. These respondents suggested that evidence gathered to date indicates that blends of up to 20% hydrogen by volume do not cause safety or usability concerns and no significant modifications should therefore be needed. One respondent also cited that projects have evidenced that fundamental gas properties, such as the Wobbe Number, may play a more significant role in appliance operation and other aspects of the gas system than variations in hydrogen blend rates.
- **No significant operational and/or user issues anticipated as arising from either fixed or varying blend percentages** was cited by 8 respondents. One of these respondents noted that gas variability already exists within the current national gas distribution system and impacts may be mitigated by providing compositional data combined with dynamic adjustment of combustion processes according to the blend received. Two respondents cited that variable percentages of up to 20% hydrogen by volume would not have a major impact on equipment. Conversely, one respondent

cited that some equipment and Heavy Goods Vehicles (HGVs) may not operate using a blend due to the make-up of the components being incompatible with hydrogen. Concerns relating to hydrogen blends on gas engines was raised by 3 respondents, who suggested these concerns could be mitigated through modifications to equipment and/or by introducing a gradual increase in the volume of hydrogen blend. One resident also raised impacts on additional equipment for the monitoring of gas quality. Another respondent pointed out that significant issues with variable blends are not expected if Wobbe limits are observed.

- **Potential impacts on industrial users, hydrogen leakage and/or loss of fracture toughness** was cited by 3 respondents, who were concerned about hydrogen blending impacts regardless of whether blending occurs at a fixed or variable percentage.

Key rationales sighted by those respondents who responded 'yes'

- **Varying fuel compositions may affect industry** was cited by 6 respondents, who cited that gas variations may require recalibration for ultrasonic meters and turbine meters, for instance. Another 3 respondents raised concerns around the potential impacts of variable blend percentages combined with Wobbe Index variations. Another respondent cited that the forthcoming (April 2025) reduction in minimum Wobbe Index allowed under the Gas Safety (Management) Regulations 1996 (GS(M)R)[5] may allow sufficient fuel variability to permit hydrogen blends of up to 20% by volume.
- **Fixed blends may be required for precise manufacturing profiles, such as in the food industry** was cited by 4 respondents, who viewed that stable gas supply compositions may assist in maintaining suitable furnace melting conditions, for instance.
- **Modifications and adaptations may be required for variable blends** was cited by 4 respondents, who mentioned potential challenges for gas engines. One respondent also cited that there is scope for the percentage of hydrogen blends to change sharply over time, leading to more abrupt changes in the physical characteristics of gas served.
- **Unpredictable hydrogen blend percentages may cause challenges** was cited by 3 respondents, citing potential challenges if blend rates cannot be predicted, which may relate to the design and adjustment of industrial processes and/or on business planning and investment.
- **Blending should be coordinated at both a local and national level** was suggested by one respondent, who noted there could be a risk of varying calorific values across a period of time and across different geographic areas. Conversely, 2 respondents cited that a fixed blend may not be practically achievable as blend rates are likely to vary in different geographic areas. This may be dependent on gas supply and demand variations, as well as the amount of blending occurring in a given geographic region.

[5] https://www.hse.gov.uk/gas/gas-safety-management-regulation-changes.htm

Question 1. c)

If applicable for your project, do you anticipate any cost impact to your business (e.g. from replacing equipment, adjusting production levels or requiring deblending equipment and processes)?

Summary of stakeholder responses to consultation

Table 3: Stakeholder response summary to Question 1. c)

Response summary	
Yes	31
No	24
Not sure	17
Not answered or unclear	57

Thirty-one respondents expressed an anticipation of cost impacts to business. The 'yes' responses of a few respondents did not pertain specifically to their respective projects, but rather a more general anticipation of costs associated with blending. A few respondents also noted that although they anticipate costs, they consider these costs to be minor. Three respondents stated cost anticipations for their specific processes, which encompassed expenses beyond those directly associated with blending for one respondent.

Twenty-four respondents did not anticipate any cost impact. One of these respondents noted that there may be significant net cost advantages of blending. Seven respondents noted that existing equipment and/or technology is well equipped to handle blending if needed, with one respondent noting that existing technology may be able to use hydrogen blends as a feedstock. One respondent cited that if blending is supported as a reserve offtaker, this may help to lower financing costs for hydrogen production projects.

Potential cost impacts

- **Costs associated with modifying, adapting, or replacing equipment, appliances, system and/or engines** were cited by 24 respondents, with some of these respondents citing that these costs may be minor. A few respondents also cited potential wider implementation costs of hydrogen blending, such as any network upgrade costs. Another respondent noted costs associated with site conversion.
- **Increased feedstock** was cited by 5 respondents as a potential cost impact of hydrogen blend.

- **No anticipated direct costs** were predicted by 2 respondents, although they noted that blending could lead to indirect costs to customers.
- **Existing gas-fired power generation plants may need to be retrofitted to run on hydrogen blends** was cited by one respondent, who viewed that this may be low cost though noted that further research would be required to review this.
- **Additional emissions monitoring may be required** was cited by one respondent.

Question 1. d)

If applicable, how long would you require to prepare your facilities to accept fixed or variable hydrogen blends? Would there be a substantive difference depending on whether the blend is a fixed or variable percentage?

Summary of stakeholder responses to consultation

Table 4: Stakeholder response summary to Question 1. d)

Response summary	
Yes	20
No	13
Not sure	16
Not answered or unclear	80

Twenty respondents provided estimates of the time they may require preparing their facilities to accept fixed or variable hydrogen blends, with most respondents not answering due to the question not being applicable to them. Although not directly applicable to them, some of the respondents who answered cited anticipated times that may be required to prepare facilities in general.

Potential time requirements

- **Exact time preparation required remains uncertain** was cited by 6 respondents, who stated that this is contingent on the outcome of the blending safety review. One respondent cited that further evidence is needed to understand any substantive differences between fixed and variable blend percentages.
- **No time requirements** to receive fixed or variable hydrogen blends was cited by 4 respondents, with one of these respondents citing that the HyDeploy trials have evidenced that additional time is not required to prepare equipment.

- **Timeframe is dependent on the availability of suitable hydrogen monitoring equipment** was cited by 3 respondents, referencing gas engine manufacturers and/or suppliers. Two of these respondents noted that fixed percentages of hydrogen might be more easily accommodated compared to variable percentages.
- **6 months** was estimated by one respondent, but further details were not provided.
- **Up to 1 year** was estimated by 4 respondents due to potential time requirements to understand and commission any required facility modifications, for instance. One of these respondents noted that the anticipated time required may be reduced through early engagement with government.
- **Up to 2 years** was cited by 3 respondents.
- **2-3 years** was estimated by 3 respondents. The timeframe included time that may be required to prepare facilities and gas engines to accept blends. Two of these respondents cited no differences depending on whether the blend is a fixed or variable percentage, and the other respondent cited that this is yet to be determined.
- **Longer time frames** were cited by 2 respondents. 3-5 years was cited by one of these respondents as time required to modify gas engines with potentially 7 years required to replace trucks, though they cited no issues relating hydrogen blends of up to 5% by volume. The other respondent cited 7-10 years being required to prepare to receive hydrogen blend rates that vary by more than 0.5% by volume in order to carry out preparatory testing, for instance.
- **Modifications could be implemented on a rolling basis** was cited by 2 respondents, who stated their intention to implement equipment conversions gradually.
- **Not feasible to prepare facilities for hydrogen blends** was highlighted by 2 respondents, with another 2 respondents noting that time requirements to accommodate fixed or variable hydrogen blends would be dependent on existing infrastructure in place.

Question 1. e)

Please provide supporting evidence about any impacts you may expect and estimates for the costs of mitigation, if applicable.

Summary of stakeholder responses to consultation

Table 5: Stakeholder response summary to Question 1. e)

Response summary	
Yes	13
No	0
Not sure	4
Not answered or unclear	112

Thirteen respondents provided supporting evidence for or referenced impacts they may expect and/or estimates for the costs of mitigation. Four respondents were not sure. Although not directly applicable to them, some of the respondents who answered cited impacts and costs that may be caused by hydrogen blending in general.

Potential impacts cited

1. **Potential impacts on households** were cited by two respondents, who noted concerns around the impact of blends on household appliances.

- **Numerous safety assessments may be required** was cited by one respondent, who viewed that assessments may be required to understand impacts on asset risks, emissions, safety, existing infrastructure integrity, performance, and leakage. The respondent cited a risk of financial penalty if there is failure to deliver under contracts due to receiving a hydrogen blend.
- **Potential impacts on existing gas turbines** were cited by one respondent.
- **A potential need for deblending** was cited by one respondent, who viewed that these costs might need to be recovered from customers.

Government response

We thank respondents for sharing their views and evidence relating to the safety and usability of hydrogen blends. We will aim to further consider the views and evidence gathered ahead of any decision on whether to enable blending into GB gas distribution networks, including as part of the government review of blending safety evidence. As noted in the consultation, the Department will continue to work closely with industry and the HSE to ensure that safety evidence is assessed independently and robustly before any implementing measures, such as potential amendments to the GS(M)R or any other legislation, are made.

Question 2 – Blending into gas transmission networks

Consultation position

There are further considerations associated with transmission-level blending that will need to be evaluated as part of the economic and safety assessments for blending into GB gas transmission networks. These include the impact of blends and/or varying blend rates on industrial end users connected at transmission-level and the possible need for mitigations such as deblending, with associated costs. We anticipate that this may be more significant for larger-scale transmission connected industrial users, compared to users connected at distribution-level. Government will also consider developments across Europe, such as in relation to the EU Hydrogen and Gas Market Decarbonisation package. The consultation sought to gather views and evidence on other potential impacts and concerns associated with transmission-level blending that were not identified in this chapter.

Question 2.

Do you have any additional views or concerns associated with blending hydrogen into GB gas transmission networks that have not been identified within this chapter? Please provide evidence to support your response.

Summary of stakeholder responses to consultation

Table 6: Stakeholder response summary to Question 2.

Response summary	
Provided views or concerns associated with blending hydrogen into GB gas transmission networks	50
Provided general views or concerns without specifically citing transmission-level blending	28
Not answered or unclear	51

Most of the responses to this question focused on issues specifically relating to blending hydrogen into the GB gas transmission networks. Of these responses, there was roughly an even split between those who were generally positive about the prospect of transmission-level blending, and those who either had concerns or withheld judgement pending further evidence and consideration.

Identified potential benefits associated with transmission-level blending

- **Benefits for hydrogen economy development** were cited by 10 respondents. These respondents cited that the opportunity to blend into the transmission network may be able to provide confidence, promote investment and lower production project costs in the early years of the hydrogen economy by potentially allowing high volumes of hydrogen to be blended. Of these respondents, most cited that such blending should only act as a reserve offtaker, stimulating investment in the hydrogen value chain by mitigating volume risk before dedicated hydrogen networks are built, whilst not 'crowding out' other offtakers. Some of these respondents suggested that blending at the higher-pressure transmission-level may be more beneficial than blending locally at a lower pressure distribution-level, while others viewed there could be a more equivalent role for both transmission-level and distribution-level blending.
- **Enabling energy system balancing** was cited by 6 respondents. These respondents cited that transmission-level blending could help enable the growth of large-scale electrolytic hydrogen production facilities in strategic locations to alleviate electricity network constraints. Some of these respondents cited that blending may be able to provide confidence to help enable growth in renewable energy capacity such as offshore wind.
- **Enabling a more consistent blend across the whole gas network** was cited by 5 respondents, who viewed that allowing transmission-level blending may enable a more consistent hydrogen blends across all gas networks compared to more variable blend rates which may be more likely to occur at the distribution-level.
- **Potentially reducing the complexity for billing arrangements** was cited by 5 respondents. These respondents noted that, given the higher capacity of the transmission network compared to the distribution network, injecting hydrogen at the transmission level would result in a lower blend percentage than injecting the same volume downstream. This may mean that transmission-level blending could potentially reduce any impact of blending on the Flow Weighted Average Calorific Value (FWACV) billing framework compared to blending at the distribution-level blending.
- **Decarbonisation benefits for industrial sites connected to the transmission network** were cited by 2 respondents, who viewed that blending may provide some early decarbonisation benefits for large-scale industrial users connected to the transmission network before dedicated hydrogen networks are built.

Identified concerns and areas for further consideration associated with transmission-level blending

- **Timelines for making this decision** were cited by 20 respondents, who noted that they would value clarity from government on the timelines involved in making a decision on transmission-level blending.

- **Safety and usability of blends for transmission networks and connected assets** was cited by 19 respondents. These respondents referenced a need for further consideration of the compatibility of existing pipelines and equipment with transmission-level blending. Twelve of these respondents specifically noted that challenges which could be faced by industrial and power generation sites connected to the transmission networks may be more significant compared to users connected at distribution-level. Eight of these respondents cited the work of the Future Grid project trials in testing blending at transmission-level. A few respondents reflected that hydrogen blends could be challenging for sites reliant on natural gas for use as a feedstock, such as CCUS-enabled hydrogen production facilities. Some respondents noted that consideration of the possible need for mitigations such as deblending, with assessment of associated costs, would be crucial to any government decision on transmission-level blending.
- **Implications for interconnectors and trade** were cited by 15 respondents. These respondents agreed with the consultation position that there was a need for further consideration of the EU's approach and timeline on transmission-level blending, with most respondents recommending an aligned approach for the ease of international gas trading. Three of these respondents framed the opportunity of aligning approaches with European neighbours as a benefit of transmission-level blending, citing that this could help enable cross-border trade and maintain energy security, while most other respondents identified this as an area for further consideration before any decisions were made.
- **Interactions between distribution-level blending and transmission-level blending** were cited by 13 respondents. These respondents cited that careful consideration of the interactions between blending at different tiers of the network would be needed. This could help to avoid the risk of 'network sterilisation', whereby a single hydrogen blending connection at the distribution network may prevent access to significant volumes of upstream blending capacity at the transmission network to avoid exceeding the blend limit at the lower-pressure tier location. Some of these respondents cited this was an argument in favour of transmission-level blending, while others noted that this was reason for further consideration to ensure that opportunities to blend at distribution-level and transmission-level would be more equivalent.

Some of the responses to this question referred to blending more broadly without referencing transmission-level blending. Of these, some were supportive of the proposed strategic role of blending, whereas most expressed disagreement with this role or concerns about blending more generally. Those generally in favour of blending cited its potential role in growing the hydrogen economy by helping to de-risk production. Those more opposed to blending cited concerns including around the potential cost of blending to consumers, the limited long-term reduction of carbon emissions resulting from blending compared to other hydrogen uses, and the risk that blending could reduce uptake of domestic heating decarbonisation technologies through a public perception that blending is a precursor to widespread hydrogen heating.

Government response

We thank respondents for their views on transmission-level hydrogen blending. Consistent with the position set out in the consultation, the strategic policy decision on blending published alongside this response is focussed on blending into the existing GB gas distribution networks only. Government will separately assess the case for supporting blending into GB gas transmission networks, which will consider evidence gathered by the Future Grid project trials for transmission-level blending. We recognise the importance of further clarity for industry on transmission-level blending, particularly given its interactions with distribution-level blending. Government will therefore aim to provide an update on timings for a transmission-level blending policy decision next year.

Chapter 3 – Strategic role of hydrogen blending

Question 3 – Strategic role of hydrogen blending

Consultation position

This chapter described our views on the strategic role of hydrogen blending to act as a reserve offtaker, to support the growth of the hydrogen economy whilst ensuring it does not 'crowd out' the supply of hydrogen to alternative end users who require it to decarbonise. Additionally, blending may have value as a potential strategic enabler for certain electrolytic hydrogen projects to support the wider energy system. The consultation sought to gather feedback on our views of the strategic role of blending, as described in this consultation chapter.

Question 3.

Do you have any comments on our views of the strategic role of blending, as described in this chapter? Please provide evidence to support your response.

Summary of stakeholder responses to consultation

Table 7: Stakeholder response summary to Question 3.

Response summary	
Agree blending could have strategic value in supporting hydrogen economy development	77
Disagree blending could have strategic value in supporting hydrogen economy development	19
Not answered or unclear	33

Most respondents agreed that blending could have strategic value in supporting the early development of the hydrogen economy, in both helping to reduce volume and investment risk for hydrogen production and by acting as a strategic enabler to support the wider energy system. Of these respondents, there was majority support for the circumstances for allowing blending as set out in the consultation. However, 24 respondents stated that blending could have additional value if it wasn't constrained to the reserve offtaker and strategic enabler roles

set out in the consultation. Conversely, some respondents disagreed that blending could have strategic value, with the view that other uses of hydrogen may be more valuable and demand side measures or hydrogen storage could be a better way of managing volume risk.

Arguments in agreement with our views of the strategic role of blending

- **Blending can reduce volume and investment risk** was cited by 41 respondents, who viewed that this may help support early hydrogen economy development. These respondents cited that, by acting as a reserve offtaker, blending can provide a route to market in the event of disruptions to offtakers, which could lead to lower financing costs for producers.
- **Blending has potential to strategically enable electrolytic hydrogen producers to support the wider energy system** was cited by 26 respondents. These respondents viewed that in the initial absence of hydrogen transport and storage infrastructure, blending could have value in reducing curtailment costs where the electricity transmission grid may experience constraints, which may in turn support the development of renewable electricity generation.
- **Blending can help reduce emissions** was cited by 12 respondents, who viewed that this could be achieved both directly through the displacement of natural gas and indirectly by accelerating the development of the wider hydrogen economy and its decarbonisation of harder-to-abate sectors.
- **Blending is more suitable than alternative measures, such as hydrogen storage, to manage volume risk** was cited by 4 respondents. These respondents cited that blending may be more viable in the short-term due to the potentially higher costs and longer lead times of developing storage infrastructure, as well as its potential geographic limitations.
- **Blending as a reserve offtaker could help increase consumer awareness and confidence in hydrogen** was cited by 5 respondents, who noted that consumer awareness of hydrogen is low and viewed that blending could help achieve a more widespread understanding and acceptance of its use. Some of these respondents cited that blending could also provide confidence in the availability of hydrogen for potential end users of 100% hydrogen to switch.

Arguments in favour of a more significant role for hydrogen blending

Of the 77 respondents who agreed that blending could have strategic value in supporting hydrogen economy development, 24 viewed that blending could provide additional value if it was supported as a primary or majority offtaker for both electrolytic and CCUS-enabled producers ahead of hydrogen transport and storage infrastructure. The key reasons are listed below.

- **Could achieve greater decarbonisation and support a potential transition to 100% hydrogen for heating** was cited by 5 respondents.
- **Scope to transition from a primary offtaker to a reserve offtaker over time** was cited by 4 respondents.
- **Role of blending could be expanded over time as the market develops** was cited by 4 respondents.
- **Could bring forward production, provide confidence in resilience of supply and therefore encourage fuel switching** was cited by 3 respondents.
- **Constraining blending to a reserve offtaker could reduce economies of scale** was cited by 2 respondents.
- **The role of blending should be equivalent for CCUS-enabled and electrolytic production pathways** was cited by 4 respondents.
- **Allowing blending as a majority offtaker for CCUS-enabled projects may allow more hydrogen supply to remote areas and dispersed sites** was cited by one respondent.

Arguments in disagreement that blending may have strategic value

- **Blending could slow down heat decarbonisation** was cited by 9 respondents. These respondents viewed that blending could potentially divert funds away from the electrification of heat, prolong the use of natural gas, slow the uptake of hydrogen where it may become a more enduring energy source, and detract focus from the roll out of alternative decarbonised heating options such as heat pumps.
- **Other measures would be more effective at managing hydrogen producer volume risk** was cited by 9 respondents. These respondents cited alternative measures including targets for hydrogen use in industry and incentives to prioritise strategic uses of hydrogen as well as storage. One respondent suggested that blending into existing gas-fired power stations along with exports could act as an alternative reserve offtaker.
- **Existing grey hydrogen users could act as a reserve offtaker for low carbon hydrogen** was cited by 8 respondents, who cited that the early production of low-carbon hydrogen should be prioritised to displace the higher carbon ‘grey hydrogen’ currently used in some industrial processes.
- **There are more valuable uses of hydrogen than blending** was cited by 7 respondents. These respondents cited that blending does not encourage the strategic deployment of hydrogen in sectors where it may be a primary option for decarbonisation, such as heavy industrial processes, and transport and storage for power generation. Five of these respondents viewed that blending risks locking in hydrogen for inefficient uses such as domestic heating.

Government response

We thank respondents for their views on the strategic role and potential strategic value of hydrogen blending. Our view, based on evidence assessed to date and consideration of the consultation responses, is that supporting blending as an offtaker of last resort, as was previously described as a 'reserve offtaker' in the consultation, and strategic enabler in certain scenarios may help to mitigate volume risk and potentially bring down production costs, whilst also helping to enable electrolytic producers to locate to support the wider energy system. As we believe that blending should only be a transitional option, we view that limiting the role of blending to these strategic use cases may help to mitigate the risk of blending 'crowding-out' higher value uses of low-carbon hydrogen with greater long-term decarbonisation potential.

Regarding alternative measures to manage volume risk, as stated in the government response to the consultation on hydrogen transport and storage infrastructure,[6] we view that, given the longer lead times for the development of hydrogen storage infrastructure, in the near-term blending may have strategic value as an offtaker of last resort. We will continue to explore the value of demand side measures to address volume risk, as well as exports, in the development of the hydrogen economy. A potential benefit of blending is that it may be a flexible and geographically extensive offtaker of last resort for a wider variety of hydrogen producers, not just those located close to existing grey hydrogen demand.

Our view on the offtaker of last resort role remains as set out in the consultation. It could apply to both electrolytic and CCUS-enabled hydrogen producers to manage the risk of offtakers falling away or not coming online as planned, for example due to bankruptcy or technical issues. In addition, the offtaker of last resort role could mitigate cross-chain risks, for example if a planned infrastructure project is delayed resulting in the producer potentially benefiting from being able to blend for a limited period from the outset. However, we do not envisage supporting CCUS-enabled projects to blend as a majority offtake ahead of larger scale transport and storage infrastructure as they cannot provide the same strategic wider energy system benefits, such as mitigating electricity transmission network constraints that electrolytic producers can.

We note that we are making a strategic decision to support blending into GB gas distribution networks based on evidence gathered and assessed to date. Following completion of the safety assessment, government will take a future decision on whether to enable blending, which will consider any implications from the safety assessment on blending's feasibility and economic case. We may then look to start any required legislative and regulatory processes to enable blending, such as any necessary amendments to the GS(M)R. As the hydrogen economy develops, including beyond these decisions, we will continue to assess the strategic role and value of blending.

[6] https://www.gov.uk/government/consultations/proposals-for-hydrogen-transport-and-storage-business-models

Chapter 4 – Commercial support models

Question 4 – Lead commercial support model

Consultation position

In developing the economic case for blending, government has considered whether blending should be supported commercially by government if it is enabled, and if so, options for how commercial support could be provided in line with the strategic role of blending. Based on the appraisal in the consultation chapter, we proposed that the most appropriate mechanism to provide support for blending, if blending is enabled and commercially supported by government, would be the Hydrogen Production Business Model (HPBM). The consultation sought to gather views and feedback on this proposal.

Question 4.

Do you agree that, if blending is enabled and commercially supported by government, the most appropriate mechanism would be via the Hydrogen Production Business Model? Please provide evidence to support your response.

Summary of stakeholder responses to consultation

Table 8: Stakeholder response summary to Question 4.

Response summary	
Agree	78
Disagree	11
Not sure	17
Not answered or unclear	23

Of the respondents who answered this question, most agreed with our consideration that the most appropriate mechanism to provide support for blending, if blending is enabled and commercially supported by the government, would be the HPBM. These respondents primarily cited the need for a form of commercial support that can be deployed quickly and without complexity.

Eleven respondents disagreed that the HPBM should be used as the mechanism to commercially support blending, with the main argument on the cost of blending relative to the

benefits that it may provide. Some of these respondents also cited concerns that blending may 'crowd out' other forms of hydrogen offtake where HPBM support should instead be focused on harder to decarbonise areas.

Seventeen respondents were not sure, either due to not having a view on this topic or citing that this was outside their area of expertise.

Arguments in support of the HPBM as the mechanism of commercial support

- **Commercial support is required** was cited by 21 respondents. These responses highlighted the case for commercial support being available for blended volumes of hydrogen, with the HPBM cited as a simple and cost-effective option, stating that without blending commercial mechanisms in place, the economics of hydrogen production for blending would be challenging, or unviable. Two of these respondents noted that reflecting the reserve offtaker role in HPBM support for blending may help bring down the cost of capital for investors and lower costs across the hydrogen industry, potentially enabling projects to take Final Investment Decisions (FIDs) and support progress towards the government's hydrogen ambitions.
- **The HPBM is the quickest and least complex way to support blending** was suggested by 33 respondents, agreeing with the rationale set out in the consultation that supporting blending through the HPBM rather than via a separate business model should reduce burdens for producers, the government, and the government appointed counterparty to manage the HPBM contracts. Respondents highlighted that with the HPBM already in place, it would be a 'ready-made' solution and could be implemented faster than other options, in turn potentially aiding a faster pace of development of the hydrogen economy. Additionally, some responses noted that the familiarity with the HPBM may avoid an increased administrative burden and increase in complexity for producers, reducing a potential challenge to investment decisions and effective operation. Many of these responses cited potential time constraints around the deployment of blending in enabling the development of the hydrogen economy, viewing that the other options presented in the consultation may result in significant time delays.
- **Blending may act as a form of volume support** was suggested by 7 respondents, potentially allowing projects to mitigate against volume risk in the period before the deployment of large-scale transportation and storage infrastructure. Some of these respondents highlighted the interaction between blending and the HPBM sliding scale, with blending potentially acting as a complementary form of volume support.
- **Supporting blending through the HPBM would increase investor confidence** was suggested by 6 respondents, citing that the ability to blend with support from the HPBM may help to de-risking projects by providing investors with greater clarity of the return of their investments.

Arguments against the HPBM as the mechanism of commercial support

- **Blending may 'crowd out' other offtakes** was highlighted by 3 respondents, reflecting our position in the consultation that we are keen to avoid distorting the offtaker market that could result in blending 'crowding out' other end users of hydrogen who require it to decarbonise. These respondents viewed that limited HPBM funding should not be diverted away from production projects that are more focussed on decarbonising harder-to-abate sectors, such as heavy industry or transport.
- **Costs of blending** were cited by 5 respondents, who viewed that taxpayers should not subsidise blending given their views on its limited climate benefit for its associated cost.

Additional points raised

- **Limited risk of blending 'crowding out' other offtakers** was cited by 5 respondents who viewed that, due to the hydrogen market's lack of maturity, there may not be a risk of blending 'crowding out' other offtakers in practice.
- **HPBM sliding scale** was cited by 6 respondents, who drew attention to the sliding scale and its potential interactions with blending. Some of these responses cited concern around the policy and regulatory interactions between blending and the sliding scale, viewing that consideration must be given to how this interaction takes place in practice. Some of these responses cited a complementary interaction, where blended volumes can help reduce the amount of support provided under the sliding scale, whilst still providing a decarbonisation benefit.
- **Low carbon hydrogen certification** was cited by 3 respondents, who suggested that consideration should be given to the value that certification could provide to HPBM supported volumes.
- **Revisions to the Low Carbon Hydrogen Agreement (LCHA)** were cited by 20 respondents, who viewed that changes would need to be made to the LCHA and on the role of Risk Taking Intermediaries (RTIs) to allow for blending to be a qualifying offtaker. Most of these respondents cited the importance of producers with existing LCHAs being allowed to make retrospective changes to incorporate blending, should HPBM support be provided for blending.
- **Level of HPBM subsidy for blended volumes** was cited by 18 respondents. Most of these respondents suggested that the level of HPBM subsidy for blending should have parity with other forms of offtake. Some of these responses cited that the cost to produce hydrogen is the same regardless of end use and that producers should not be penalised when using blending as a reserve. Conversely, some of these respondents suggested that the level of HPBM subsidy for blending offtake should be lower than other forms of offtake, to provide an incentive to drive production volumes towards higher value uses of hydrogen.

Government response

We thank respondents for sharing their views on commercial support models for blending. In light of the evidence received, we have decided to progress with the proposed option to support blending through the HPBM, should a decision to enable hydrogen blending be taken by government following assessment of the blending safety evidence. Hydrogen produced for blending is currently defined as a non-qualifying offtaker under the HPBM and a producer is therefore not currently eligible to receive subsidy support. In the event of a positive decision to enable blending, we would look to amend this restriction to enable a producer to receive subsidy support deemed necessary for volumes that are blended.

In amending the HPBM, we would consider the level of subsidy support for blended volumes to ensure it is consistent with the strategic role of blending and the minimum necessary subsidy. We are keen to avoid distorting the offtaker market that could result in blending 'crowding out' other end users of hydrogen who require it to decarbonise by determining any conditions or criteria under which subsidy support may be provided. Any subsidy support provided for blending would need to be reflected in the HPBM contract, the LCHA, where blending is currently a non-qualifying offtaker. We would need to consider further how the LCHA would accommodate blending, interaction with existing design measures within the HPBM (e.g. sliding scale and RTIs), technical requirements (e.g. metering and billing), and the level of subsidy support for blended volumes. This work would also consider the potential role blending could play for strategically enabling certain electrolytic hydrogen production projects to support the wider energy system.

We intend to continue engaging stakeholders on the design of any subsidy support for blending (via working groups and bilateral engagement) as we develop further thinking and policy positions in these areas, including blending's potential eligibility as a qualifying offtaker, whilst reflecting its strategic role, for future contract allocation rounds via the Hydrogen Allocation Rounds and the CCUS Cluster Sequencing Process. We currently envisage a CCUS-enabled hydrogen project only including blending as an offtaker of last resort, as was previously described as a 'reserve offtaker' in the consultation, but for electrolytic projects there may be a case for supporting blending as a strategic enabler to manage grid constraints as a precursor to regional or national hydrogen transport and storage infrastructure in certain locations.

Chapter 5 – Market and trading arrangements

Question 5 – Lead option for market and trading arrangements

Consultation position

This chapter considered the market and trading arrangements for hydrogen blending, if enabled, in the context of the current gas market and trading arrangements, including the question of which market participants could purchase hydrogen produced for blending. It sought views and feedback on the lead option proposed which was to allow a hybrid approach for blending market and trading arrangements where both licenced gas distribution network (GDN) operators and licenced gas shippers are able to purchase hydrogen produced for blending, and shippers are able to sell hydrogen produced for blending, if blending is enabled by government.

Question 5.

Do you agree with the proposed lead option to allow both gas distribution network operators and gas shippers to purchase hydrogen produced for blending? Please provide evidence to support your response.

Summary of stakeholder responses to consultation

Table 9: Stakeholder response summary to Question 5.

Response summary	
Agree	72
Disagree	8
Not sure	20
Not answered or unclear	29

Most respondents agreed with our lead option to allow both GDNs and gas shippers to purchase hydrogen produced for blending. Key reasons cited include that this may offer the most flexible route to market for blended volumes of hydrogen, with minimal changes to current gas market and trading arrangements.

A few respondents disagreed with the question, with some of these respondents citing concerns around the lead option for market and trading arrangements and 3 disagreeing with the use of hydrogen for blending more generally, without referencing market and trading arrangements.

Arguments in agreement with our lead option

- **A hybrid approach may offer producers the most flexible route to market** was cited by 26 respondents. Some of these respondents noted that this may increase liquidity in the low carbon hydrogen market.
- **A hybrid approach would increase the volumes of hydrogen that could be blended in comparison to a GDN-led approach** was cited by 14 respondents, as if hydrogen was used only to replace shrinkage gas, this may limit blending to approximately 0.5% hydrogen by volume. Some of these respondents added that the hybrid approach would therefore maximise the decarbonisation potential of blending.
- **A hybrid approach may enable the GDNs to vary hydrogen entry volumes to maintain the blended gas specification within an acceptable range** was cited by 11 respondents, who were of the view that this would be lacking under a shipper-led approach.
- **A hybrid approach mirrors existing arrangements for natural gas** was cited by 10 respondents, who noted that this may make this option relatively straightforward and non-disruptive to implement.
- **A hybrid approach may help GDNs meet Environmental, Social, and Governance (ESG) targets** was cited by 5 respondents, because natural gas used for shrinkage gas could be replaced with low carbon hydrogen under a hybrid approach, as may not be viable under a shipper-led approach.
- **A hybrid approach may help enable hydrogen to be traded like gas, as quantity of energy** was cited by 4 respondents. Some of these respondents said that there may nevertheless be some complexities to be resolved.

Arguments against our lead option

- **GDNs should be prohibited from purchasing hydrogen for blending** was cited by 2 respondents, who were of the view that this may be more similar to current gas trading models.
- **It is not clear that allowing unrestricted sales of hydrogen to gas shippers would align with the strategic objective of blending as a reserve offtaker** was cited by 2 respondents.

Other main comments made by stakeholders

- **The HPBM would need to be amended to allow the sale of hydrogen to RTIs for blended volumes** was cited by 10 respondents.
- **Extending the hybrid approach to include blending into the GB transmission system would increase shrinkage demand for hydrogen** was cited by 9 respondents.
- **GDNs and/or shippers could be placed under an obligation to purchase hydrogen, potentially through their licences** was cited by 8 respondents. Some of these respondents said that for GDNs, the obligation could be equivalent to their shrinkage gas volumes.
- **Disagreements with use of hydrogen for blending more generally** were cited by 3 respondents, who did not specifically refer to market and trading arrangements.
- **Enabling of blending may require changes to be made to the Uniform Network Code (UNC), GDN price controls and Shrinkage Leakage Models (SLMs)** was cited by 2 respondents.

Government response

We thank respondents for sharing their views on our proposed lead option to allow both the GDNs and licenced gas shippers to purchase hydrogen produced for blending.

As part of the strategic policy decision to support blending of up to 20% hydrogen by volume into GB gas distribution networks, government has decided to strategically support a hybrid approach for blending market and trading arrangements where both GDN operators and gas shippers are able to purchase hydrogen produced for blending, and shippers are able to sell hydrogen produced for blending, if blending is enabled by government.

We note that sales of hydrogen to RTIs, which would include gas shippers, are not currently an eligible offtaker under the HPBM. Further consideration will be given to the commercial design and integration of blending within the HPBM, as set out in the government response to Question 4.

Question 6 – Treatment of low carbon hydrogen certificates for blending

Consultation position

The government has committed to setting up a certification scheme for low carbon hydrogen from 2025 and consulted in Spring 2023 on proposals for the scheme's design.[7] If certificates for blended volumes are tradable, this could create a commercial incentive for hydrogen producers to prioritise blending over other offtakers, as they could extract a price premium for certificates issued to gas shippers who could onward trade to suppliers/retail market and extract further value in the form of low carbon energy products and tariffs. In the consultation, we communicated a minded to position to disincentivise certificates (from both the government scheme and similar schemes) for blended hydrogen from being traded by precluding the onward sale of certificates after the point of injection. The consultation sought views and feedback on this minded to position.

Question 6.

Given blending's proposed strategic role as a reserve offtaker, do you agree that certificates for low carbon hydrogen injected into the gas network should be precluded from onward sale after the point of injection? Please provide evidence to support your response.

Summary of stakeholder responses to consultation

Table 10: Stakeholder response summary to Question 6.

Response summary	
Agree	20
Disagree	51
Not sure	31
Not answered or unclear	27

Some respondents agreed with our proposal to preclude the onward sale of certificates after the point of injection. The main reason cited was similar to the rationale set out in the

[7] https://www.gov.uk/government/consultations/uk-low-carbon-hydrogen-certification-scheme

consultation around not over-incentivising blending and positioning the certification scheme in line with the strategic role of blending.

Conversely, around half of the respondents disagreed with the government's proposal with the main reason being that certificates could be used to generate revenue for producers and therefore may reduce government subsidy under the HPBM.

Many respondents said they were not sure, stating although they could see the government's reasoning behind not wanting to incentivise certificates, they also shared similar views to those mentioned above in the 'disagree' category.

Arguments in support of precluding the onward sale of certificates after the point of injection

- **Government should not over-incentivise blending, in-keeping with blending's strategic role** was cited by 6 respondents, who agreed with the rationale set out in the consultation around preventing the trading of certificates, as they may provide a commercial incentive to blend and possibly 'crowd out' supply to higher-priority hydrogen offtakers. Two respondents said certification should be used to reinforce a differential in value for producers to maintain blending as a reserve offtaker.
- **Greenwashing risks and impacts on domestic consumers** were mentioned by 2 respondents. One respondent was concerned that for domestic consumers, selling hydrogen certificates as part of a green tariff may not be appropriate and would create a greenwashing risk from misinformation to these consumers, given that blending is a transitional measure and not a full decarbonisation solution for homes.

Arguments against precluding the sale of certificates after the point of injection

- **Creating a secondary market for certificates and generating additional revenue for producers and government** was cited by 18 respondents. These respondents noted that the sale of certificates alongside the blended volume of hydrogen may enable producers to gain a higher achieved sales price, which could potentially allow producers to gain more revenue and reduce the amount of subsidy required from government under the HPBM. Six of these respondents referenced a precedent in the form of Renewable Energy Guarantees of Origin (REGO) and Renewable Gas Guarantees of Origin (RGGO) schemes, stating that they had helped to support market growth of other energy sectors.
- **Allowing the use of low carbon hydrogen certificates to meet UK Emissions Trading System (ETS) obligations** was suggested by 15 respondents, stating that if certificates were fungible with UK Allowances, this would increase their value by achieving price parity with the ETS, potentially reducing government subsidy required, as mentioned above. These 15 respondents also highlighted a precedent from certification for biomethane withdrawn from the gas grid to prove a reduction in greenhouse gas (GHG) emissions at registered EU ETS installations.

- **Enabling the non-physical decarbonisation of dispersed sites in the short-to-medium-term** was mentioned by 15 respondents. These respondents suggested that certification for low carbon hydrogen should be used to 'offset' emissions where sites are situated outside of industrial clusters, as they cited that these sites are responsible for around half of the GHG emissions from the industrial sector and are less easily able to benefit from hydrogen production in the near-term. A few respondents suggested that certificates could be phased out over time as hydrogen transport and storage infrastructure is deployed.
- **'Crowding out' risk is unlikely to materialise or could be managed** was mentioned by 11 respondents, stating that the potential upper limit on blending of 20% hydrogen by volume would ensure that the role of blending would be limited, and that contractual arrangements under the Low Carbon Hydrogen Agreement could also be used to ensure that producers seek agreements with higher priority offtakers where possible.

Government response

We thank respondents for sharing their views on low carbon hydrogen certification schemes and blending. We acknowledge the concerns raised by respondents around the potential need to use certification as a way of generating additional revenue for low carbon hydrogen to support the growth of the hydrogen economy, particularly for blended volumes of hydrogen ahead of more widespread deployment of transport and storage infrastructure.

Government remains committed to ensuring certification schemes for low carbon hydrogen are used to provide a reliable means of verifying the emissions credentials of low carbon hydrogen and has recently published the key design features of its certification scheme in a separate government consultation response,[8] including committing to using a mass balance chain of custody. Mass balance ensures that the end user who is using the hydrogen (and therefore seeing a reduction in their emissions from combusting it) is also the one making a sustainability claim using a certificate. However, in a blending scenario, it is not feasible to trace the low carbon hydrogen once injected, therefore the trading arrangements for mass balance would need to be loosened.

Given the issues raised by industry and the complexities with implementing a mass balance scheme in a blending scenario, **government plans to consider further its position on low carbon hydrogen certification for blending. We aim to take a decision on how certificates should be treated in a blending scenario ahead of the launch of the certification scheme.** This will allow government to engage further with industry on this issue ahead of reaching a decision.

Respondents also proposed that certificates are used to meet UK Emissions Trading Scheme (UK ETS) obligations, however government confirmed earlier this year in the consultation on

[8] https://www.gov.uk/government/consultations/uk-low-carbon-hydrogen-certification-scheme

certification that certificates could not be used in the UK ETS.[9] This is because an installation who has received a hydrogen blend will see a reduction in their emissions (depending on their monitoring method) and therefore see a reduction in their UK ETS bill. If a certificate for the blended hydrogen was traded separately and claimed by another UK ETS installation alongside surrendering UK Allowances, this could constitute as double counting given two decarbonisation benefits have been derived from one corresponding volume of low carbon hydrogen.

We would like to note that this decision is related to low carbon hydrogen which is injected into GB gas distribution networks. Government will separately assess the case for blending into GB transmissions networks, including interactions with certification. As set out in consultation and strategic policy decision there are further considerations associated with transmission-level blending such as in relation to the EU Hydrogen and Gas Market Decarbonisation package, and any implications on international gas trading agreements.

9 https://assets.publishing.service.gov.uk/media/63e4c736d3bf7f05c4a886d5/consultation_on_a_UK_low_carbon_hydrogen_certification_scheme.pdf

Chapter 6 – Technical delivery models

Question 7 – Lead option for technical delivery models

Consultation position

The technical delivery model for hydrogen blending would help determine where hydrogen would be injected into the GB gas networks and how this should be managed. The consultation proposed that our lead option, based on evidence gathered and assessed to date, is to adopt the free-market approach, as described by the Gas Goes Green programme,[10] as the preferred technical delivery model for hydrogen blending, should hydrogen blending be enabled by government. The free-market approach mimics the existing arrangements for connections to the gas network and would let the market decide where to inject hydrogen into the network. We sought views and feedback on this lead technical delivery model option.

Question 7.

Do you agree with our lead option to adopt the free-market approach as the preferred technical delivery model for hydrogen blending, should blending be enabled by government? Please provide evidence to support your response.

Summary of stakeholder responses to consultation

Table 11: Stakeholder response summary to Question 7.

Response summary	
Agree	51
Disagree	20
Not sure	22
Not answered or unclear	36

Most respondents agreed with our lead option to adopt the free-market approach as the preferred technical delivery for hydrogen blending, should blending be enabled. A key reason cited was that this approach may benefit a wider diversity of hydrogen producers of different

[10] https://www-energynetworks-org.webpkgcache.com/doc/-/s/www.energynetworks.org/industry-hub/resource-library/britains-hydrogen-blending-delivery-plan.pdf (Accessed in December 2023)

sizes and at different locations, which may help to maximise the roll-out and geographic extent of blending. Another key reason cited was that this is the least change option from current gas technical delivery models and may therefore be the quickest and least complex to implement. Some of these respondents thought that a degree of strategic planning would be necessary even under a free market approach, with a few respondents citing that the two ideas are not mutually exclusive.

Some respondents disagreed with our lead option to adopt the free-market approach as the preferred technical delivery for hydrogen blending, should blending be enabled. The primary reason cited was that strategic oversight may be required to help manage market development and help avoid the risk of 'network sterilisation', where a single hydrogen blending connection at a low-pressure tier of the network may prevent access to significant volumes of upstream blending capacity (to avoid exceeding the blend limit at the low-pressure tier location). Of the 20 respondents that disagreed with our lead option, 2 respondents disagreed with hydrogen blending more generally, without citing technical delivery models.

Some respondents were not sure whether to agree with our lead option to adopt the free-market approach as the preferred technical delivery for hydrogen blending, should blending be enabled. Of these 22 respondents, 6 respondents cited that some degree of strategic planning may be necessary, such as through a hybrid approach.

Arguments in agreement with our lead option for technical delivery models

- **Supporting producers of different scales and locations** was cited by 19 respondents. Ten of these respondents cited that the free-market approach may be able to maximise the geographic extent of blending and provide greater access to its potential benefits, including for dispersed production sites. Eight of these respondents cited that this would increase the flexibility of blending which may help facilitate development of a diverse hydrogen production market. One respondent cited that this option may reduce the distance travelled by hydrogen purchased for the purposes of blending, potentially reducing transportation costs for some producers seeking to blend.
- **Taking the least change approach may facilitate early delivery** was cited by 15 respondents, as this option is similar to current gas network arrangements. Two of these respondents cited that adopting a strategic approach may require legislative change, with associated complexity and timeline requirements.
- **Avoiding unnecessary intervention** was cited by 7 respondents, who cited that it would be preferable to let the free market determine the best approach and locations for blending.
- **Achieving the strategic aims of blending** was cited by 3 respondents. These respondents cited that the strategic policy intents for blending could be best realised under a free-market approach, such as by helping to maximise the geographic extent of blending.

Arguments in disagreement with our lead option for technical delivery models

- **At least some degree of strategic planning may be required** was cited by 36 respondents. Most of these respondents cited that some regional or national coordination may be required to help ensure that blending occurs where it is of most strategic value and/or to maximise potential hydrogen injection volumes. Nineteen of these respondents cited that complexities in network capacity allocation under a free market approach may lead to 'network sterilisation', where a single hydrogen blending connection at a low-pressure tier of the network may prevent access to significant volumes of upstream blending capacity (to avoid exceeding the blend limit at the low-pressure tier location). Seven of these respondents cited that without some degree of strategic planning, 'first-movers' and/or those producers located at hydrogen clusters may benefit the most from blending.
- **May lead to more variable blend rates** was cited by 5 respondents. These respondents noted that permitting blending at a wider variety of pressure tiers and locations may cause a greater variation in blend rates across the network which may add complexity for some connected gas users.

Additional points raised

- **Achieving a hybrid model would be preferential** was cited by 25 respondents. Ten of these respondents cited that developing an appropriate capacity allocation framework within the free-market approach may help to realise some of the potential benefits of both a free-market and a strategic approach.
- **Interactions with transmission-level blending** were cited by 10 respondents. Three of these respondents cited that strategic planning may be required for hydrogen blending at both distribution and transmission-level to help ensure coordination between the networks.
- **Technical delivery model options could be revisited in future** was cited by 8 respondents, who thought that the technical delivery model could be kept under review as the hydrogen economy develops and that this decision could be revisited if valuable.
- **Comparisons to biomethane blending** were cited by 2 respondents, who cited that current capacity allocation mechanisms have caused some challenges for biomethane injections into the grid.

Government response

We thank respondents for their views on our lead option for technical delivery models, should hydrogen blending be enabled. As part of the strategic policy decision to support blending of up to 20% hydrogen by volume into GB gas distribution networks, government has decided to adopt the free-market approach, as described by the Gas Goes Green programme, as the

technical delivery model for hydrogen blending, if enabled. This approach mimics the existing arrangements for connections to the gas network and would let the market decide where to inject hydrogen into the network. Theoretically, blending could occur wherever hydrogen producers apply to connect, which could be at any location and pressure tier across a GDN thereby maximising the potential geographic extent of blending. It would be for the gas network operator to monitor hydrogen levels across their network to ensure a maximum hydrogen level is not breached, as they do for current gases in the GDNs.

We will continue to work closely with the GDN operators and wider industry to explore the most appropriate means to allocate capacity for hydrogen injections under the free market approach, should blending be enabled by government. Through appropriate design of capacity allocation procedures, we view that a sufficient degree of strategic planning may be realised to help mitigate some of those risks identified by respondents around the free market approach, such as in relation to ‘network sterilisation’, and we aim to keep this process under review.

We note the possibility that a review of blending safety evidence could suggest that blending is not suitable in specific regions of the GDNs. If this occurs, we will consider whether this could still align with the free-market approach and, if needed, consider an alternative technical delivery model.

Question 8 – Locations and timeframes for connecting to a gas distribution network

Consultation position

Government will continue to work closely with the GDNs operators and wider industry stakeholders to explore the most appropriate means to allocate capacity for hydrogen injection under the free market approach, should blending be enabled by government. In this question we sought to better understand where hydrogen producers might be looking to connect to the GDNs for the purposes of hydrogen blending and indicative timeframes for such connections.

Question 8.

If your project is considering connecting to a gas distribution network for the purposes of hydrogen blending, where would that connection be (in terms of geographic region and/or pressure tier on the network)? Please provide an indicative timeframe for when you may want to connect.

Summary of stakeholder responses to consultation

Table 12: Stakeholder response summary to Question 8.

Response summary	
Answered	15
Not answered or unclear	114

Fifteen respondents to this question indicated that they were involved with hydrogen production projects that were considering connecting to the gas distribution network for the purposes of blending. Whilst 2 of these respondents did not identify where they might connect their projects to the distribution network, others gave some indication. Seventeen potential connections were identified in England - 4 in southern England, 7 in central England (including East Anglia), 4 in northeast England (including Humber) and 2 in northwest England. Respondents said a further 8 connections in Scotland were being considered – one in the borders, 3 in central Scotland (Edinburgh, South Lanarkshire and Fife) and 3 in northeast Scotland. One connection was identified only as being in Scotland.

Respondents had mixed views on which pressure tier they expected to connect to the gas distribution network at. Whilst some thought there was greatest merit in connecting at the highest-pressure tier, others were less specific or thought that there should be scope for

projects to connect locally in order to minimise requirements for additional transportation infrastructure.

In terms of timeframes for connection to the gas distribution network, around half of the respondents said their need for a connection would not materialise for at least four years. The remainder of respondents were either unsure when they might need a connection or thought that the need may arise sooner.

Government response

We thank those stakeholders who shared information relating to their project plans. This will help enable government to develop a better understanding of the extent to which blending may prove beneficial to hydrogen producers as well as the potential distribution of blending entry points on the GB gas distribution networks.

Question 9 – Lead option for gas billing arrangements

Consultation position

The Future Billing Methodology Project (FBM), conducted by industry (networks, consultants) with funding agreed under Ofgem's Gas Network Innovation Competition, produced a report that provides options and recommendations on how the attribution of energy content (CV) for billing could be treated in a future with a wider variety of gas sources, such as hydrogen.[11] Of those options identified by the FBM, our lead option, based on evidence gathered and assessed to date, would be to adopt Option A (working within existing frameworks) from the FBM Report as the preferred approach to billing, should hydrogen blending be enabled. In practice, this option should not require immediate changes to the existing gas billing methodology, ensuring that the pace of rollout for hydrogen blending, if it is enabled by government, is not delayed by a need for changes to billing arrangements. Although hydrogen blending under Option A would likely limit the permitted level of hydrogen blending to be below 20% by volume across the GB gas distribution networks in practice (to ensure that variations in gas CV are maintained within current regulatory limits and ensure fairness for consumers), we do not view this as being incompatible with our strategic objectives for blending. We sought views and feedback on this lead gas billing arrangements option.

Question 9.

Do you agree with our lead option to adopt Option A (working within existing frameworks) from the Future Billing Methodology Report as the preferred approach to gas billing, should blending be enabled by government? Please provide evidence to support your response.

Summary of stakeholder responses to consultation

Table 13: Stakeholder response summary to Question 9.

Response summary	
Agree	66
Disagree	5
Not sure	23
Not answered or unclear	35

[11] https://www.xoserve.com/media/43317/xos1434_xoserve-fbm-consultation-output-v7-final.pdf (Accessed in November 2023)

Most respondents agreed with our lead option to adopt Option A (working within existing frameworks) from the FBM Report as the preferred approach to billing, should hydrogen blending be enabled. The key reason cited was that this option would represent the least change from current gas billing arrangements, potentially facilitating an earlier implementation for hydrogen blending. Some of these respondents cited that this is the least costly option and some cited that this option could achieve the strategic aims of blending without requiring further changes to gas billing arrangements.

A few respondents disagreed with our lead option to adopt Option A (working within existing frameworks) from the FBM Report as the preferred approach to billing, should hydrogen blending be enabled. Some of these respondents cited concerns around using recommendations from the FBM and 2 of these respondents disagreed with hydrogen blending more generally, without citing gas billing arrangements.

Some respondents were not sure whether to agree with our lead option to adopt Option A (working within existing frameworks) from the FBM Report as the preferred approach to billing, should hydrogen blending be enabled. Four of these respondents cited that amendments to gas billing arrangements may be valuable in future, whilst citing that there is logic in initially working within existing frameworks.

Arguments in agreement with our lead option for gas billing arrangements

- **Quickest to implement option with minimal** changes was cited by 32 respondents. Most of these respondents cited that this is the least-change option and may therefore facilitate the earliest implementation of hydrogen blending. Three of these respondents also cited that using existing billing arrangements may reduce complexity and resource burden for affected industry parties compared to options to amend gas billing arrangements.
- **Least-cost option** was cited by 11 respondents, with two of these respondents citing that cost impacts on consumers should be minimised.
- **Achieves the strategic aims of blending** was cited by 10 respondents, who noted that the strategic aims of blending may be realised under existing billing frameworks. Three of these respondents cited that, as blending may be a transitional offtaker for hydrogen, there may be minimal benefits in amending billing arrangements to help facilitate hydrogen blending.

Arguments in disagreement with our lead option for gas billing arrangements

- **Concerns with using recommendations from the FBM** was cited by 4 respondents. Three of these respondents cited that cost estimates for CV-measuring technologies provided through the FBM may be outdated compared to cheaper modern technologies, which could make options to amend gas billing arrangements more economically feasible. One of these respondents cited concerns around the FBM's use of biomethane for testing, rather than hydrogen.

Additional points raised

- **Amending gas billing arrangements should be considered over a more suitable timeframe** was cited by 24 respondents. Nineteen of these respondents cited that there may be value in implementing blending under existing billing frameworks initially whilst potentially amending gas billing arrangements over a more suitable timeframe. Conversely, 5 respondents cited that the costs associated with amending billing arrangements may be excessive given our views on the transitional nature of blending.
- **Interactions with biomethane** were cited by 5 respondents, who noted that amending gas billing arrangements may also help to facilitate biomethane injections into the grid.
- **Interactions with transmission-level blending** were cited by 4 respondents. Two of these respondents cited that flexible billing arrangements may help to facilitate blending at both distribution and transmission-level.
- **Interactions with blending technical delivery models** were cited by 3 respondents, who viewed that any reduction in hydrogen blending capacity caused by billing arrangements may strengthen the case for a strategic approach to blending technical delivery models, as explored in Question 7 of the consultation.

Government response

We thank respondents for their views on our lead option for gas billing arrangements, should hydrogen blending be enabled. As part of the strategic policy decision to support blending of up to 20% hydrogen by volume into GB gas distribution networks, government has decided to adopt Option A (working within existing frameworks) from the Future Billing Methodology Report as the preferred approach to billing, should hydrogen blending be enabled. In practice, this option should not require immediate changes to the existing gas billing methodology.

Although hydrogen blending under Option A would likely limit the permitted level of hydrogen blending to be below 20% by volume across the GB gas distribution networks in practice (to ensure that variations in gas CV are maintained within current regulatory limits and ensure fairness for consumers), we do not view this as being incompatible with our strategic objectives for blending, as outlined in response to Question 3. Significant amounts of hydrogen blending could be achieved under the existing billing regulations, and this is the lowest cost and quickest to implement option for hydrogen blending.

As noted in the consultation, we assess that a decision on whether to undertake a feasibility study into the concept of online CV modelling for billing (Option C) can be taken separately to a policy decision on hydrogen blending. We do not currently intend to announce further details on this option as part of our policy development for hydrogen blending.

Economic analysis

Question 10 – Feedback on economic analysis

Consultation position

The consultation included an economic analysis on hydrogen blending, based on current evidence, to help inform a strategic policy decision on whether to support blending of up to 20% hydrogen by volume into GB gas distribution networks. As blending trials progress and safety evidence is reviewed, if further costs are revealed, the costs and benefits associated with blending will be considered again. We invited views and feedback on our economic analysis of blending in the consultation.

Question 10.

We welcome feedback on the economic analysis presented in this section and corresponding annex. Please provide evidence to support your response.

Summary of stakeholder responses to consultation

Table 14: Stakeholder response summary to Question 10.

Response summary	
Answered	54
Not answered or unclear	75

Feedback provided on the economic analysis

Of the 129 consultation responses, 54 commented on the economic analysis presented in the consultation. The feedback was varied and whilst some respondents discussed whether they agreed or disagreed with the conclusions drawn from the analysis, most responses also provided suggestions for additional analysis and other things to consider.

There were 16 respondents that agreed with the economic analysis and/or were supportive of hydrogen blending into GB gas distribution networks having reviewed this analysis. Twelve of these respondents provided positive feedback on the quality of the economic analysis, broadly agreed with the methodology and conclusions being drawn from it and provided detailed additional feedback. Alternatively, seven of the respondents disagreed with the conclusions within the economic analysis.

Arguments in agreement with the economic analysis presented in the consultation

- **Lowering financing risks** was cited by 8 respondents. These respondents agreed with the notion that blending may provide offtaker certainty, help to manage volume and revenue risks and as a result, may lower financing costs and encourage investment. One of these respondents mentioned that quantifying the change in the risk premium could bring value to the analysis.
- **Supporting development of the hydrogen economy** was cited by 2 respondents. They mentioned that blending may reduce barriers to entry for new hydrogen producers and, through increased investment, may encourage development of the wider hydrogen economy and progress towards decarbonisation.

Arguments in disagreement with the economic analysis presented in the consultation

Conversely, 7 respondents disagreed with the analysis and of these, 5 advised not to proceed with blending. The main reason for questioning the analysis included:

- **Inconclusive evidence** was cited by 5 respondents, who viewed that the lack of some quantified costs at this stage does not provide a conclusive view on the value for money case for blending.

Suggestions for additional analysis and/or refinement of the consultation's analysis

- **Updated costs considerations** were cited by 16 respondents. The main themes included:
    - **Transport and storage.** Two respondents viewed that blending may defer or remove some short-term hydrogen storage costs. Another commented on potential benefits to industrial users as a blend of up to 20% by volume may utilise existing pipelines for hydrogen transportation.
    - **Cost to industry.** Three respondents cited that the analysis should consider the impacts of blending on sensitive industries, for example the costs of any deblending infrastructure that may be required, in addition to considering injection infrastructure costs.
    - **Costs to the consumer.** Six respondents expressed views on potential cost impacts to consumers due to blending. These respondents considered whether any costs for infrastructure amendments and upgrades to the gas system, that may be required for hydrogen blending, would be passed onto the consumer.
- **Geographical implications** were cited by 8 respondents who stated that the consultation did not fully consider the impact of site locations and in particular, the role of blending for dispersed sites. These respondents viewed that there should be more consideration of where we expect injection sites to be located.

- **Infrastructure certainty** was cited by 4 respondents who emphasise the importance of infrastructure and timing/expectation of when it can be built. These respondents highlighted that for blending to realise one of its main benefits of reducing volume risk and encouraging investment, this is reliant on the guarantee of infrastructure construction and the need for this to be in place immediately to realise the benefits.

Additional feedback on hydrogen blending more generally

- **Cost of electrification** was cited by 2 respondents, who viewed that blending as a partial decarbonisation option for heat that may be available at a lower cost to consumers than electrification options.
- **Carbon savings** were cited by 2 respondents. These respondents stated that the carbon reduction benefits achieved through blending should not be undervalued and should be at the core of decarbonisation strategy when comparing blending to alternative fossil fuels.
- **Alternative uses for low carbon hydrogen** were cited by 4 respondents, with suggestions including low carbon hydrogen's use in shipping and in displacing current use of grey hydrogen.
- **Transmission-level blending** was cited by 3 respondents, with a suggestion to consider developing policy for this in parallel with policy development for distribution-level blending.

Government response

We thank respondents sharing their views, suggestions and feedback on the economic analysis. We note that a handful of responses referred to the evidence presented as being inconclusive and were of the view that it may be too early to make a decision on blending and that the safety review should be completed first. Whilst we appreciate this feedback, as stated in the consultation, the initial policy decision will be a strategic decision and whether blending is enabled will still be subject to the outcome of the wider safety review. The economic case uses the best currently available data on costs and benefits to inform the strategic decision on blending. The feedback provided through this consultation does not change the outcome of the economic case. Although respondents suggested additional categories of costs that could be included, for example, costs to industry, no new evidence was provided on the scale of these costs. We anticipate that if there are potential costs to industry these would be revealed through the safety case and if additional costs are revealed, we intend to incorporate these into future economic analyses alongside the safety review. Other suggestions made by respondents on additional analysis to incorporate, for example, geographical implications, would not change the conclusion of the economic case, but could provide more detail on the potential use cases of blending and we will look to incorporate this into future analyses.

A few respondents requested additional analysis on the costs and benefits of transmission-level blending. We acknowledge this feedback and note that any decision on transmission-level blending is outside the scope of this consultation. We will consider such analysis in the future as part of policy development for any decision on blending into the GB gas transmission networks.

Acronyms

Acronym	Definition
CCUS	Carbon Capture, Usage and Storage
ESG	Environmental, Social, and Governance
ETS	Emissions Trading Scheme
EU	European Union
FID	Final investment decisions
FWACV	Flow Weighted Average Calorific Value
GB	Great Britain
GDN	Gas distribution network
GHG	Greenhouse gas
GS(M)R	Gas Safety (Management) Regulations 1996
HGV	Heavy Goods Vehicle
HPBM	Hydrogen Production Business Model
HSE	Health and Safety Executive
LCHA	Low Carbon Hydrogen Agreement
REGO	Renewable Energy Guarantees of Origin
RGGO	Renewable Gas Guarantees of Origin
RTI	Risk Taking Intermediary
SLM	Shrinkage Leakage Models
UK	United Kingdom
UNC	Uniform Network Code

This publication is available from: https://www.gov.uk/government/consultations/hydrogen-blending-into-gb-gas-distribution-networks

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