Department for
Business, Energy
& Industrial Strategy

The UK Low Carbon Hydrogen Standard

Government response to consultation

April 2022

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Contents

1. General Information

1.1. Background

The Prime Minister's *Ten Point Plan for a Green Industrial Revolution*[1] committed to focus on driving innovation, boosting export opportunities, and generating green jobs and growth across the country to level up regions of the UK. To build on this, government published the *Net Zero Strategy*[2], setting out a long-term plan to deliver our legally binding targets under the Climate Change Act. Both documents pointed to the role of low carbon hydrogen in meeting our emission reduction targets while generating economic growth in the UK.

The Ten Point Plan included an ambition for 5GW of low carbon hydrogen production capacity in the UK by 2030 and in August 2021 the Government published the UK Hydrogen Strategy, outlining a comprehensive roadmap for the development of the hydrogen economy to deliver this ambition. However, with an increased focus on energy independence as set out in the Energy Security Strategy, we have now doubled our UK ambition to up to 10GW of low carbon hydrogen production capacity by 2030, subject to affordability and value for money, with at least half of this being from electrolytic hydrogen, drawing on the scale up of the UK's renewables and new nuclear capacity. The UK Low Carbon Hydrogen standard ("the standard") has already been designed to accommodate all production pathways capable of meeting the requirements under the standard, including hydrogen from nuclear pathways, and the increased ambition for new nuclear this decade opens up further opportunities for nuclear hydrogen. The Net Zero Hydrogen Fund (NZHF) and Low Carbon Hydrogen Business Model (HBM) have also been designed to support all forms of hydrogen production, including from nuclear energy, provided projects meet eligibility requirements.

Alongside the publication of the UK Hydrogen Strategy government consulted on the design for a UK Low Carbon Hydrogen Standard to define what we mean by 'low carbon' hydrogen. The standard will establish a maximum threshold for greenhouse gas (GHG) emissions in the production process for hydrogen to be considered low carbon, and a methodology for calculating emissions.

The standard will initially be used to ensure that hydrogen production supported by the NZHF and HBM is sufficiently low carbon. Producers applying for government funding through these two schemes will have to comply with the requirements set out in the standard guidance document to receive funding.

[1] https://www.gov.uk/government/publications/the-ten-point-plan-for-a-green-industrial-revolution
[2] https://www.gov.uk/government/publications/net-zero-strategy

The standard is only intended to cover the role of hydrogen in the energy system up to the point of production and is not intended to replace or impact on any standards, regulations or other government guidance covering the transmission, storage, or use of hydrogen. Producers should be aware that other regulations and requirements may already be in place that will need to be complied with, dependent on how the hydrogen is used. For example, hydrogen for use in a fuel cell vehicle would need to meet a certain level of purity and would also need to meet additional requirements to qualify as 'renewable' under the Renewable Transport Fuel Obligation (RTFO).

Other government schemes or policies may choose to adopt the standard methodology in future, to assess whether the supported hydrogen production can be considered low carbon. As set out in the Energy Security Strategy, we will be setting up a hydrogen certification scheme by 2025, to underpin deployment of low carbon hydrogen and support future international trade. We will engage further with industry on this in due course.

Given that the low carbon hydrogen market is at such an early stage, with less than 5MW of low carbon hydrogen production capacity in the UK at present, we will need time to understand how the standard will work in practice. We also need to strike a balance between ensuring lowest possible emissions from individual plants, and encouraging significant growth of a new sector, mindful that the major carbon benefits will come from the 2030s when we achieve deployment at a significant scale. We therefore expect to update the standard at designated review points to ensure it remains fit for purpose and reflects our growing understanding of how new technologies work in practice, including how hydrogen production interacts with the broader energy system. We would expect any updates to the standard to be timed in line with future contract awards through the NZHF/ HBM and would not expect any changes to be applied retrospectively to contracts that have already been awarded funding through these schemes. We expect the first review of the standard guidance document to be in early 2023, taking into account learnings from the 2022 allocation rounds.

We are publishing this response to the consultation on the standard alongside several other documents:

- The UK Low Carbon Hydrogen Standard guidance document[3]: this sets out in detail the methodology for calculating the emissions associated with hydrogen production and the steps producers are expected to take to prove that the hydrogen they produce is compliant with the standard. The document also sets out sustainability criteria that biomass hydrogen producers will need to meet and how to put a risk mitigation plan in place for fugitive hydrogen emissions in production. Further detail on the criteria for specific hydrogen

[3] https://www.gov.uk/government/publications/uk-low-carbon-hydrogen-standard-emissions-reporting-and-sustainability-criteria

production pathways can be found in Annexes A - E. The guidance document should be used by hydrogen producers seeking support from government schemes and policies that apply the standard. The guidance document is open for comment from interested parties within the territory of a WTO Member as outlined below.

- Net Zero Hydrogen Fund government response[4]: this sets out the proposed scope, design and delivery of the £240 million NZHF, which will make grant funding available to support the capital costs of developing and building low carbon hydrogen production projects.
- Low Carbon Hydrogen Business Model government response[5]: this sets out the proposed policy and current thinking on the different aspects of the HBM. The HBM aims to overcome the cost gap between low carbon hydrogen and higher carbon counterfactual fuels to enable low carbon hydrogen production to develop rapidly at scale.
- Indicative Heads of Terms for the hydrogen business model: this sets out a preliminary and indicative framework for the principal terms and conditions that are expected to be included in the contract underpinning the hydrogen business model – the Low Carbon Hydrogen Agreement (LCHA).
- Electrolytic Allocation Market Engagement document: this seeks views on a proposed approach to allocating HBM and NZHF support to electrolytic hydrogen projects.
- The Hydrogen Investor Roadmap[6]: The Roadmap showcases the UK's hydrogen offer and the scale of our ambition for the role of the hydrogen economy in meeting Net Zero. It spotlights the exciting investment opportunities across the hydrogen value chain – from production, through transmission and storage to the range of potential end uses, including power, transport and heating.

1.2. Enquiries to the UK Low Carbon Hydrogen Standard

UK Low Carbon Hydrogen Standard Team, Department for Business, Energy and Industrial Strategy

[4] https://www.gov.uk/government/consultations/designing-the-net-zero-hydrogen-fund
[5] https://www.gov.uk/government/consultations/design-of-a-business-model-for-low-carbon-hydrogen
[6] https://www.gov.uk/government/publications/hydrogen-investor-roadmap-leading-the-way-to-net-zero

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Territorial extent: UK wide

2. Executive Summary

This document responds to the consultation on "Designing a UK Low Carbon Hydrogen Standard", which ran from 17 August 2021 to 25 October 2021[7]. We are grateful for the feedback we received to the consultation, both in terms of the 125 formal responses, and through various stakeholder engagement events during the consultation period.

Following consideration of stakeholder feedback and further analysis, we are now setting out our proposed policy design for the UK Low Carbon Hydrogen Standard. Hydrogen producers seeking support through government schemes and policies that apply the standard, such as the Net Zero Hydrogen Fund (NZHF) and Hydrogen Business Model (HBM), will need to prove compliance with the standard. For the HBM and NZHF, this means that:

- Projects will be required to demonstrate that they can meet the standard requirements at the point of applying for government support through the HBM and NZHF.
- Depending on the government scheme in question, projects may also be required to prove ongoing compliance with the standard. For example, throughout the duration of their HBM contract, producers will need to demonstrate that volumes of hydrogen produced meet the standard in order to qualify for and receive HBM funding.
- We confirm the minded to position set out in our consultation that the HBM contract will not require producers to comply with future amendments to the standard for the purpose of receiving HBM support after the contract is signed.

Alongside the main threshold for GHG emissions allowed in the production process for hydrogen to be considered low carbon, we consulted on a range of detailed methodological choices as outlined below.

- **Threshold for GHG emissions**

In setting a GHG emissions threshold, we sought to strike a balance between the need to encourage growth by supporting market development, while ensuring that the standard makes a direct contribution to our carbon reductions targets. The standard will have a single threshold using absolute emissions. The threshold, set at point of production, will be $20gCO_2e/MJ_{LHV}$ (Lower Heating Value) of hydrogen. We

[7] https://www.gov.uk/government/consultations/designing-a-uk-low-carbon-hydrogen-standard

will review the threshold over time to ensure it is consistent with what is expected from industry and our net zero commitments.

There will be no leeway on the threshold for existing hydrogen production facilities. One of the principles underpinning the standard is to treat all technologies equally.

- **Scope of the standard**

The standard will apply to hydrogen production supported by the NZHF and HBM, with one label that defines 'low carbon hydrogen'. It will cover the methodology for UK production pathways only at this stage, although as set out in the Energy Security Strategy, we will be setting up a hydrogen certification scheme by 2025, to underpin deployment of low carbon hydrogen and support future international trade. We will engage further with industry on this in due course. BEIS has therefore been mindful of considering international consistency in the development of methodology for the standard.

System boundary, value chain interactions and emission factors

Where we set the system boundary interacts with other decisions across the supply chain, including delivery conditions (pressure and purity) and how we assess compliance of hydrogen produced through the value chain (chain of custody). We also had to consider what emissions could be included / excluded in the calculation of GHG emissions such as materiality threshold, global warming potential of hydrogen and carbon capture and utilisation.

System Boundary

The system boundary will be set at point of production. This means that a decision around chain of custody is not necessary at this stage. As the standard is developed into a certification scheme by 2025 to underpin deployment of low carbon hydrogen and support future international trade we will consult on this further with industry.

Accounting for fugitive hydrogen emissions

We consulted on whether the standard should include a Global Warming Potential (GWP) factor to account for fugitive emissions associated with hydrogen production. While we will not be including this in emissions calculations at this stage, we do recognise that fugitive emissions from hydrogen production plants could have a material impact on the atmosphere if not addressed. We therefore expect that a hydrogen GWP factor will be included at a future review point once further data has been gathered. Hydrogen producers applying for funding through government schemes applying the standard such as the NZHF and HBM are expected to report their hydrogen fugitive emissions separately as part of their application process and/or ongoing compliance monitoring and should take all necessary measure to reduce their fugitive emissions. We are providing guidance for hydrogen producers on how best to reduce their fugitive emissions and applicant guidance for the relevant government schemes will provide more details on requirements relating to fugitive emissions.

Pressure and Purity Levels

We understand that hydrogen may be produced at different pressures or purity, depending on how that hydrogen is then transported and used. Compliance with the standard will not require actual compression or purification to a defined value, so producers can agree specifications with their off-takers. However, as these processes can impact on emissions, we will be setting a theoretical minimum pressure of 3MPa and a theoretical minimum purity of 99.9%. to enable fair comparison of projects applying for funding. If a hydrogen producer has pressure and/or purity at or above the minimum values, they should include the actual GHG emissions associated with any compression or purification in their Life Cycle Analysis (LCA). If a hydrogen producer has pressure and/or purity below the theoretical minimum, then they should calculate the GHG emissions associated with theoretically compressing to 3MPa and/or purification to 99.9%. The data required to do this will be provided in the standard guidance document.

Materiality Threshold

A materiality threshold sets the percentage of emissions data that can be omitted from the LCA, for example if it is too hard or costly to collect, or if the individual data points are too small. We will not be setting a materiality threshold under the standard. To comply with the standard hydrogen producers will need to consider all emissions.

Carbon Capture and Utilisation

Carbon captured and utilisation (CCU) will not be given carbon reduction credits under the standard, meaning that carbon captured and utilised rather than permanently stored in geologic structures will be considered as being emitted to the atmosphere. Given that this is an area of limited data, we will review CCU accounting at future standard review points and will consider any emerging evidence.

- **Consideration of different primary energy inputs and feedstock emissions**

In this section, we considered how to account for specific primary energy inputs and feedstocks, including the potential impact of their use on the wider energy system, and the requirements for production facilities using mixed inputs.

Low carbon electricity input requirements

In line with the UK's Hydrogen Strategy, a range of production pathways will be permitted under the standard if producers can provide clear evidence of meeting the technical requirements for low carbon electricity input. This includes allowing the use of averaging of different electricity inputs, for example grid imported electricity consignments with low carbon electricity consignments, on a monthly basis. This approach will provide flexibility in how the standard is met, whilst maintaining the integrity of the standard threshold.

Additionality

Whilst we recognise that projects that comply with additionality principles can bring system benefits and emissions reductions, we will not be adopting an additionality requirement for hydrogen production to meet the standard. We have considered the system-wide implications of setting an additionality requirement in the standard and deem that it could constrain deployment of electrolytic hydrogen production in the 2020s and impact our ability to deliver long-term end-use emissions savings. We propose a proportionate approach is to set out clear additionality principles and incentivise hydrogen producers to meet these through allocation of HBM and NZHF support. For example, in the HBM / NZHF Market Engagement document on Electrolytic Allocation, we propose an assessment criterion on additionality of electricity source, which will be used to score projects applying to the 2022 HBM/ NZHF electrolytic allocation round on the extent to which they meet the additionality principles set out later in this document. Further information will be shared in the application guidance document for the allocation round.

In line with the position on low carbon electricity, we will not require additionality conditions to be met for biomethane inputs to prove compliance with the standard at this stage. However, BEIS may seek to incentivise additionality for biomethane inputs (where funding is made available to this production route) through the allocation of government support.

Accounting for waste fossil feedstocks

When accounting for emissions, the standard will not consider fossil waste feedstocks with counterfactuals at this stage. This means that these feedstocks will not be treated differently from other fossil-based inputs, such as oil or natural gas, when conducting emissions calculations. We will keep this under review and update as necessary dependent on further evidence, analysis, and cross-government work on GHG accounting for waste-based fuels.

Mixed inputs

The standard will have a consignment basis for the treatments of mixed inputs, allowing for both discrete consignments from a single measurable input or averaged consignments based on the average of multiple discrete consignments.

- **Further GHG methodology / calculation considerations**

Further methodological choices were consulted on, as set out below.

Unit of reference

As the unit of reference in the standard and accompanying guidance, we will use grams of carbon dioxide emissions per megajoule, lower heating value (gCO_2e/MJ_{LHV}) of produced hydrogen. This ensures consistency with comparable schemes.

By-product hydrogen

We will not include a methodology on the allocation of emissions for by-product hydrogen in the standard. Further research needs to be conducted and additional evidence considered before such pathways are included in the standard in future.

Negative emissions

Negative emissions will be accounted for and reported under the standard, provided they are genuine, associated directly with the hydrogen production process, and not 'claimed' elsewhere. Further details on negative emissions accounting can be found in the standard guidance document.

Biomass sustainability

The use of biomass will be subject to additional sustainability criteria under the standard, which is consistent with the requirements of the Renewable Transport Fuel Obligation (RTFO)[8]. In addition, the standard requires that at least 50% of hydrogen (by energy content) from biogenic feedstocks is produced using wastes or residues, in line with the requirements of the Green Gas Support Scheme (GGSS).

- **Delivery and administration of a UK low carbon hydrogen standard**

This section sets out the type of data that producers are expected to provide to prove compliance with the standard when applying for financial support, as well as delivery and verification considerations. Further detail can be found in the guidance document.

To receive funding under the HBM and certain NZHF funding windows, producers will need to provide evidence of compliance with the standard at eligibility and assessment stage and throughout the lifetime of their contract or funding agreement, which may include self-reporting and third-party verification. The counterparty / third-party organisations / administrators appointed to administer such schemes will

[8] The Renewable Transport Fuel Obligation Order regulates renewable fuels used for transport: https://www.gov.uk/guidance/renewable-transport-fuels-obligation

ensure compliance with the standard. The requirements for the verification process will be set out in the UK Low Carbon Hydrogen Standard Guidance Document and will be aligned with the requirements for the HBM payment mechanism and HBM and NZHF contractual processes. As set out in the Energy Security Strategy, we will also be setting up a hydrogen certification scheme by 2025, to underpin deployment of low carbon hydrogen and support future international trade. We will engage further with industry on this in due course.

Actual or default data

Producers will need to demonstrate compliance with the standard methodology and GHG emissions threshold by providing data evidencing the material flows and associated emissions. This can be collected via measurement or through process calculations. The standard encourages the use of actual data or projected where appropriate, however conservative default data will also be provided.

How the standard will be applied

A draft guidance document is being published alongside this government response, which clearly sets out what the minimum requirements for hydrogen production are to be considered ‘low carbon’. If no material comments are received within 60 days of publishing the draft from interested parties within the territory of a WTO Member, we will take this draft as being finalised. The guidance document would be applicable to hydrogen producers seeking support through government schemes and policies applying the standard. An emissions calculation tool will also be provided to applicants when the first NZHF application window opens, to support producers in calculating the emissions associated with their planned production route ahead of applying for government support. This should provide clarity to producers and investors in terms of the types of projects that could be eligible for support.

3. Next steps

The standard guidance document published alongside this government response sets out the steps hydrogen producers seeking support from any government funding schemes that apply the standard will need to take to ensure their hydrogen production pathway is sufficiently low carbon. Such hydrogen producers should consider this a minimum requirement for greenhouse gas emissions in production of hydrogen, noting it does not apply to the transportation, storage, or use of hydrogen. Where applicable, producers should familiarise themselves with wider environmental standards or regulations that may apply to the production, transportation, storage, or use of hydrogen. This includes eligibility for other government schemes that might support the use (rather than the production) of hydrogen, such as the RTFO for transport fuels.

As we consider the development of a certification scheme we would expect to build on the principles set out in this standard, which may provide scope to address wider market considerations, such as the role of imports in meeting future demand. Trade-based certification schemes take time to develop, however, and operators will need time to implement processes to ensure compliance. Appropriate legislation will also need to be put in place to facilitate such a mechanism.

As set out throughout this government response, we will conduct further analysis and research on certain elements of the standard design before we consider whether or how to include them under the standard in the future. This is for instance the case for the Global Warming Potential of hydrogen, for embodied emissions, for non GHG impacts of hydrogen, and for by-product hydrogen. We will also further consider our approach on the utilisation of captured carbon and waste-derived hydrogen production, amongst other issues, seeking a consistent cross government approach as far as possible. As the hydrogen economy is developing, we will continue to work with industry and other stakeholders to ensure that the standard can take these developments into account.

4. Consultation exercise

4.1. About the consultation

The UK Low Carbon Hydrogen Standard consultation sought views on the methodological choices underpinning the UK Low Carbon Hydrogen Standard, and the GHG emissions threshold for 'low carbon hydrogen'.

In the consultation, we were particularly interested in understanding stakeholders' views on the following methodological questions:

- The scope of the standard
- The system boundary
- The energy inputs and feedstock emissions
- The GHG methodology
- The GHG emissions thresholds
- The delivery and administration of the standard

4.2. About the Government response

This document summarises the 125 responses we received from a wide variety of stakeholders during the consultation on the UK Low Carbon Hydrogen Standard. For each question we asked in the consultation, the document presents the qualitative and quantitative analysis of the responses received and demonstrates how the feedback has been incorporated into the UK Low Carbon Hydrogen Standard methodology. It also outlines our response to each of these questions.

The key themes of the responses have been summarised in tables included in Annex A. The responses have helped shape the design of the UK Low Carbon Hydrogen Standard Guidance document and informed methodological choices.

5. Conducting the consultation exercise

The consultation period was open from 17 August 2021 to 25 October 2021 during which 31 bilateral meetings, three roundtables, four trade body events, and two large Q&A sessions (each with over 100 attendees) took place. The Devolved Administrations were also consulted.

Official responses were received via CitizenSpace or email. The government is grateful for the views that were received as part of the consultation process.

We have engaged extensively with industry and international partners on the potential design of the UK Low Carbon Hydrogen Standard, including members of the International Partnership for Hydrogen and Fuel Cells in the Economy such as the EU. Without prejudice as to whether this is a standard for the purpose of the Code of Good Practice under the WTO Agreement on the Technical Barriers to Trade (the "Code") consistent with the Code, we welcome comments on this draft from interested parties within the territory of a WTO Member. Should there be no material comments after 60 days (6th June 2022), we will take this draft as being finalised.

5.1. Presentation of the analysis

Throughout the document, we refer to the 125 companies, organisations or individuals who provided answers to the questions as respondents.

A summary of the analysis of these responses is provided for each question and further information can be found in the thematic tables presented in Annex A. We have indicated whether the feedback supported our proposal at consultation.

The responses are presented in total number and as a percentage of responses. Several responses came in the form of statements rather than as responses to specific questions in the consultation.

We have included a summary of the themes in these responses in Annex C.

5.2. Consultation responses

The consultation received 125 responses in total from a wide range of stakeholders including organisations involved in hydrogen production projects, as well as wider energy stakeholders, trade associations, local government, academics, consultancies, and non-governmental organisations.

5.3. Overall approach to questions

The consultation consisted of 42 questions[9]. Some questions set out a minded to position, asking respondents whether they agreed with that position.

Some had an initial closed element, such as yes or no, followed by an opportunity to provide more detail or expand on that question. For these, we identified key themes, and a percentage calculated of the total responses which discussed this theme.

A number of the responses received by email were entirely free form and the 'yes/no' aspect of such answers had to be inferred where possible. Where this was not possible for a specific question, we have categorised them as 'other'. The last question of the consultation asked respondents for any other comment they might have on the proposals set out in the document.

In our response to each question, we respond to the feedback, outline our intent, and offer further detail or an explanation of the policies where necessary.

[9] See the full list of questions in Annex D.

6. Scope

The government response sets out the main policy design elements of the standard and responds to the comments received for each question in the consultation document.

The standard guidance document is published alongside this government response and sets out in detail the methodology underpinning the standard and the steps hydrogen producers seeking to prove compliance with the standard are expected to take. Where appropriate, the guidance document expands on the government response and outlines the methodology that will be used to assess the compliance of hydrogen with the standard for hydrogen producers seeking support through any government schemes or policies that apply the standard.

We expect that the standard will be applicable across those hydrogen production pathways that are able to comply with the standard guidance on GHG emissions reporting, relevant biomass sustainability criteria (where applicable) and fugitive emissions requirements set out in the standard guidance.

Wider environmental impacts are not within the scope of the standard, but will be considered as part of our broader work on our hydrogen production strategy.

Government, industry, and academia have worked together through the Hydrogen Advisory Council's Low Carbon Hydrogen Standard Working Group (previously known as the 'Standard and Regulations Working Group')[10] to define a set of eight criteria that have guided the choices made throughout development of the low carbon hydrogen standard:

Inclusive

- Open to all potential production routes and different scale of production.
- Treating all technology pathways equally based on GHG emissions alone.
- Supports the production of hydrogen that can be used by different end users.
- Flexible and able to deal with the addition of new and more complex routes or unique circumstances.

Accessible

- Cost-effective, with appropriate and acceptable costs of compliance for operators and for the scheme administrator.
- Simple, user-friendly, and adapted to business requirements.

[10] www.gov.uk/government/groups/hydrogen-advisory-council

Transparent

- Information is freely available about the approach, assumptions, impacts and process for making future changes.
- Impartiality is maintained in all decision making.
- Stakeholders can actively engage with governance, assurance, monitoring and proposed changes.

Compatible

- Can operate alongside UK schemes for other energy vectors (e.g. fuels, power), has the ability to convert certificates between vectors (if applicable), and uses comparable GHG emission metrics.
- Is compatible with other countries' hydrogen standards, facilitating international trade.

Ambitious

- Consistent with the UK's net zero pathway requirements.
- Low threshold for allowable GHG emissions, with other sustainability criteria defined where needed.
- Use of conservative assumptions if defining default GHG emission values.
- Supporting innovation and improved chain lifecycle GHG savings over time.

Accurate

- Low uncertainties regarding GHG emissions estimates and any categorisations or labels.

Robust

- Avoidance of fraud and misuse, with strong penalties in place.
- Frequency of reporting and auditing is adapted to the complexity of supply chains and identified risk levels, implementing at least a 'limited' assurance level.
- Priority is given to auditors' skills and training, and strong grievance procedures established.

Predictable

- Providing investment security for the industry, and the ability to reliably forecast compliance.
- Limited likelihood of large swings in GHG emission values which may tip marginal chains close to a threshold over in certain years.

As set out in the consultation document, the following issues are deemed out of scope for this work on a UK low carbon hydrogen standard, and are covered by other existing workstreams in BEIS, the Department for Transport, the Department for Environment, Food, and Rural Affairs, and the Health and Safety Executive:

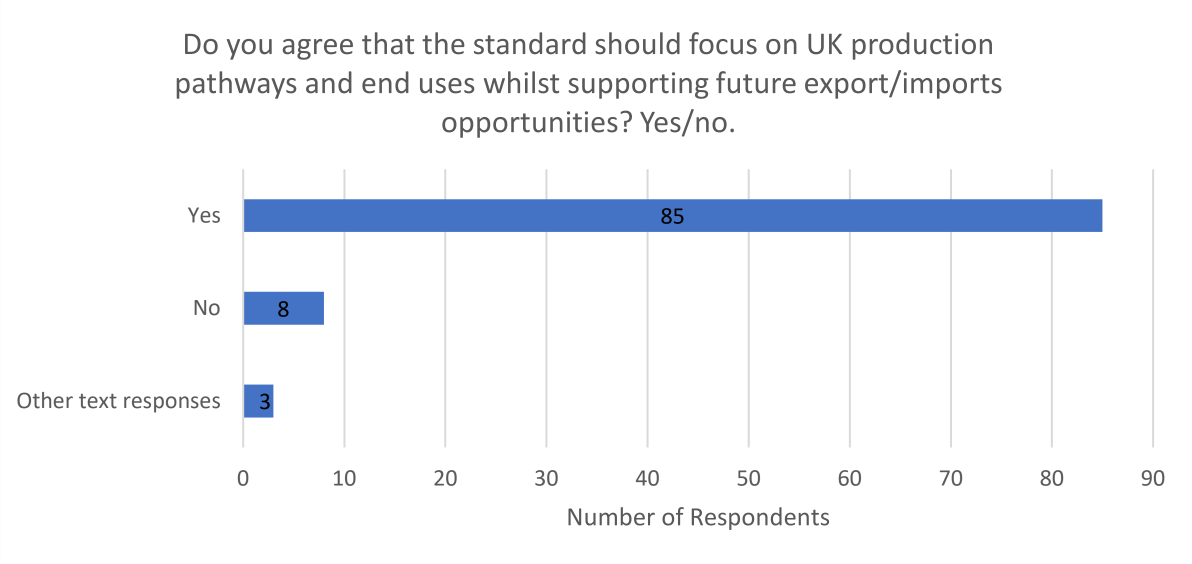
- End use safety / quality standards e.g., regulations for use of hydrogen in transport, or regulations on hydrogen boilers.
- Gas Safety (Management) Regulations and entry standards for blending hydrogen into the gas grid.
- Standards for other (non-hydrogen) decarbonised gases.
- Wider environmental standards and regulations (e.g., water consumption, air quality), though we are not excluding the potential for further work on these areas later. Hydrogen producers will still need to comply with current and future regulations on air pollutants including nitrogen oxides (NOx).
- Gas quality – e.g., the Wobbe Index.

7. Government response

7.1. Scope

Q1. Do you agree that the standard should focus on UK production pathways and end uses whilst supporting future export / import opportunities? Yes/no. Please expand on your response.

Summary of responses



Most respondents (89%) agree that the standard should focus on UK production pathways and end uses, whilst supporting future export / import opportunities. Only 8% did not agree, and the remaining 3% left an unclear response. 87 of the respondents left further comments, which have been grouped into themes in the Question 1 response themes table in Annex A.

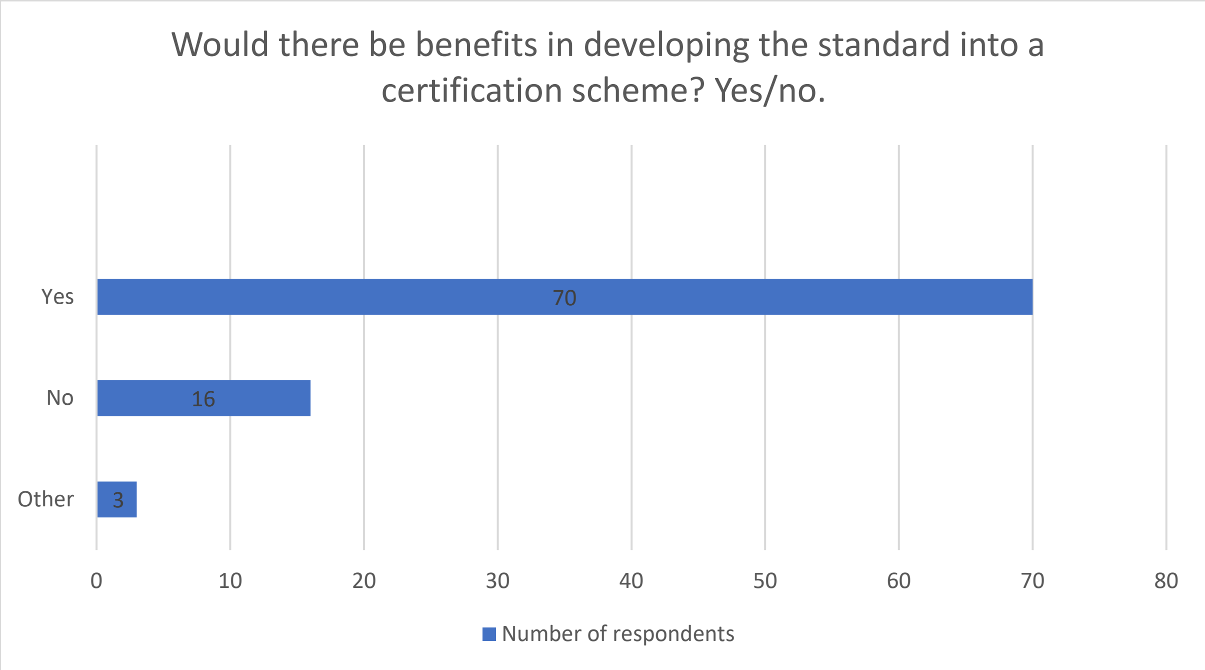
Our response

The primary purpose of the standard is to ensure that through the NZHF and HBM, government supports hydrogen production projects that are truly 'low carbon'. While government's focus is to support the UK production pipeline, the methodology was designed in a way that is consistent with the UK's international partners so we can be well equipped for future global trade opportunities. The methodology has been in part informed by work through the International Partnership for Hydrogen and Fuel Cells in the Economy (IPHE) to agree a common international methodology to calculate emissions associated with hydrogen production, in which the UK actively participates.

The standard will continue to evolve over time in line with our trajectory to net zero, technological advances, and international developments. As set out in the Energy Security Strategy, we will also be setting up a hydrogen certification scheme by 2025, to underpin deployment of low carbon hydrogen and support future international trade. We will engage further with industry on this in due course.

Q2. Would there be benefits in developing the standard into a certification scheme? Yes/no. Please provide detail.

Summary of responses



The majority (79%) of respondents agree that there would be benefits to developing the standard into a certification scheme. The benefits identified varied and included increased compliance, buyer confidence and increased market growth. The 18% of respondents who did not agree that there were benefits believed that a certification scheme would add complexity and delay market growth.

The main themes which emerged in respondents who agreed a certification scheme would be beneficial are summarised in the Q2 (Agree) response themes table in Annex A. These included increased compliance and buyer confidence and the promotion of low carbon sources. It was also noted that a clear mechanism for identifying sources of low carbon hydrogen that meet the standard would help build confidence in the market and inform eligibility for any relevant government funding or exemptions, particularly as more customers and investors ask producers to demonstrate their actions to cut emissions.

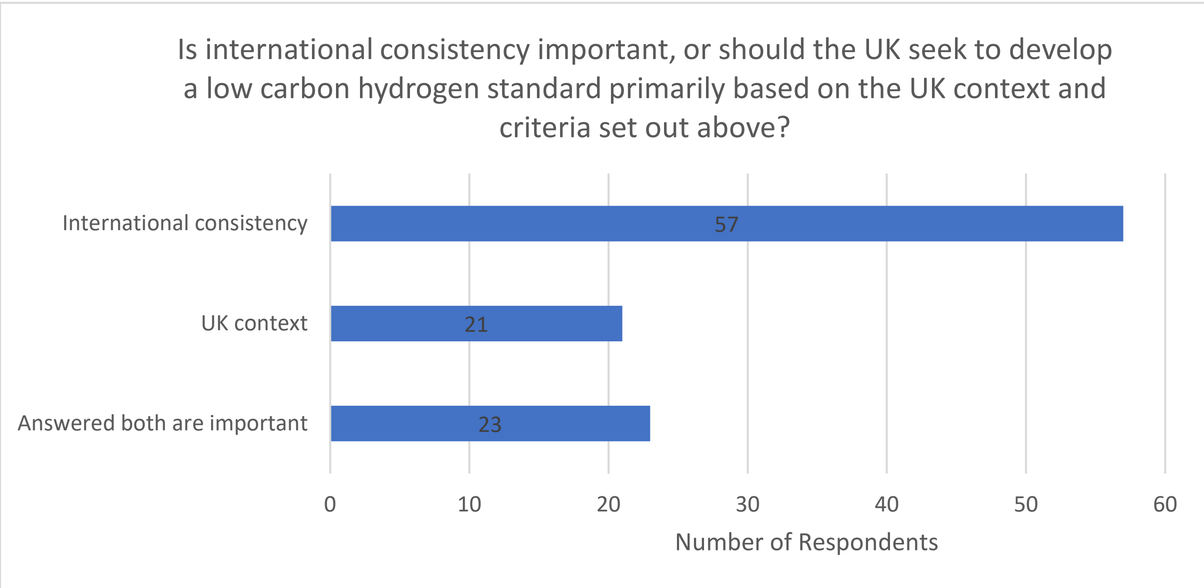
In addition, two themes emerged from respondents who commented that a certification scheme would not bring any benefits and are summarised in the Q2 (Disagree) response themes table in Annex A. There was, for example, clear feedback that the administrative burden should be kept to a minimum.

Our response

Based on the support of 79% of respondents we will be setting up a hydrogen certification scheme by 2025, to underpin deployment of low carbon hydrogen and support future international trade. We will engage further with industry on this in due course to better understand the costs, timeline and practical implications of introducing such a scheme.

Q3a. Is international consistency important, or should the UK seek to develop a low carbon hydrogen standard primarily based on the UK context and criteria set out above? Please provide detail.
Q3b. If elements of a UK standard differ to comparable international standards or definitions, would this impact the ability to facilitate investment in the UK or cause issues for business operations across borders? Yes/no/unclear at this stage. Please provide detail.
Q3c. If answering yes to 3b, what elements of existing low carbon hydrogen standards or definitions are most important to ensure international consistency?

Summary of responses



The majority of respondents recognised the importance of international consistency. Of those respondents that placed greater importance on the UK context, most acknowledged that international alignment was also important for the liquidity of the future market, and many considered that the short term (2020s) should be the main focus.

However, the majority of respondents highlighted that mindfulness of international developments should be encouraged from the outset.

The most common theme among these responses was that a differing standard would make the international trade difficult. Concerns relating to the determent of cross-border trade, weaker carbon standards, and a scarcity of low carbon hydrogen were also frequently raised.

There were 82 responses which detailed the potential impacts of the UK standard differing from comparable international standards. Further detail can be found in the question 3 response themes tables.

Our response

There are clear benefits of alignment with international standards, and we are working closely with international partners to ensure the UK's competitiveness in a global hydrogen economy.

Our starting point was considering ISO standards 14064-2, 14067, and the GHG Protocol[11], which provide overarching GHG accounting methodologies to assist in setting the system boundary and the emissions in scope. The system boundary and methodology set out is broadly in line with the ISO standards.

As there is currently no common international standard for low carbon hydrogen, we have developed the methodology and the threshold in a way that supports the UK's ambition of up to 10GW production capacity, whilst ensuring consistency with GHG accounting methodologies and our overall net zero commitment.

Respondents highlighted helpful elements to ensure international consistency, such as the broad methodology for calculating emissions and system boundary, where this could reduce trade barriers and support cross-border investment. While we believe our methodology and system boundary is broadly aligned with international standards, we will continue to consider these points as the global hydrogen market develops. However, as discussed in the UK Hydrogen Strategy[12] we want to ensure that the standard reflects the UK's unique assets and policy approach to supporting a range of low carbon hydrogen production pathways.

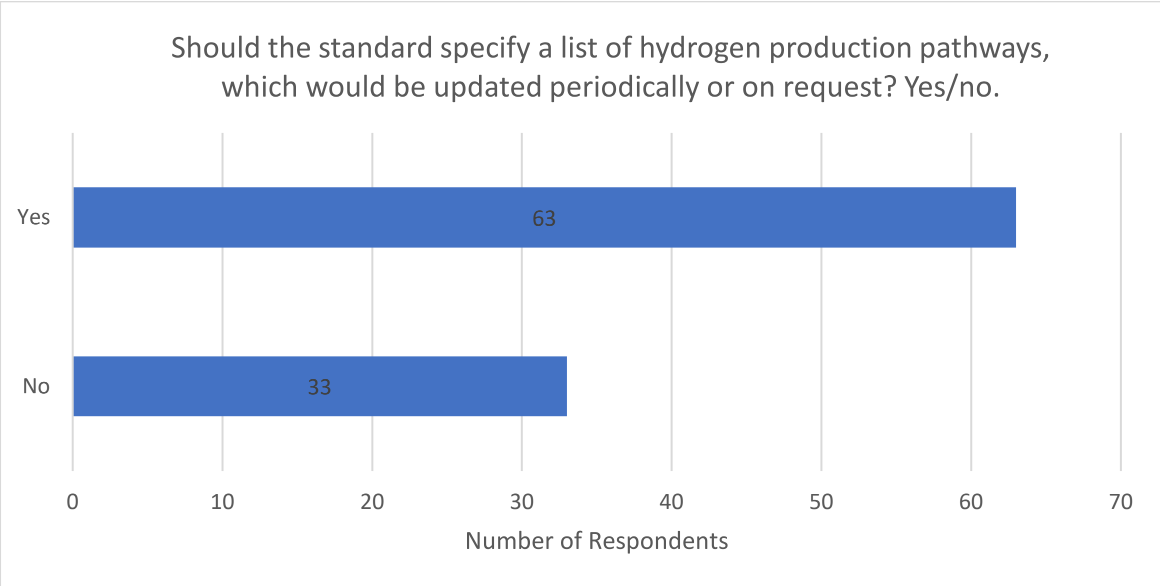
[11] ISO 14040 Environmental Management Life Cycle Assessment Principles and Framework
ISO 14044 Environmental Management Life Cycle Assessment Requirements and Guidelines
ISO 14067 Greenhouse gases — Carbon footprint of products — Requirements and guidelines for quantification
GHG Protocol- https://ghgprotocol.org/

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

We look forward to continuing working with our partners through the IPHE and other fora to develop a common framework for emissions accounting for hydrogen production in the longer term.

Q4a. Should the standard specify a list of hydrogen production pathways, which would be updated periodically or on request? Yes/no.
Q4b. If yes, we would welcome respondents' views on what production methods could have significant potential in the UK in the near term.
Q4c. If no, we would welcome respondents' views on alternative options.

Summary of responses



The majority of respondents (66%) agree with a specific pathway list for the standard. Of these, a similar majority reference electrolytic hydrogen production pathways as having significant potential, specifically through electrolysis of water using renewable energy sources (69%). The second most suggested production pathway was hydrogen from CCS enabled natural gas reformation (29%). It is worth noting that some respondents who supported green hydrogen also support blue hydrogen but recognised that each had both short and long-term benefits. Other production pathway suggestions were made by respondents, which have been gathered in the Q4(b) and Q4(c) response themes table in Annex A.

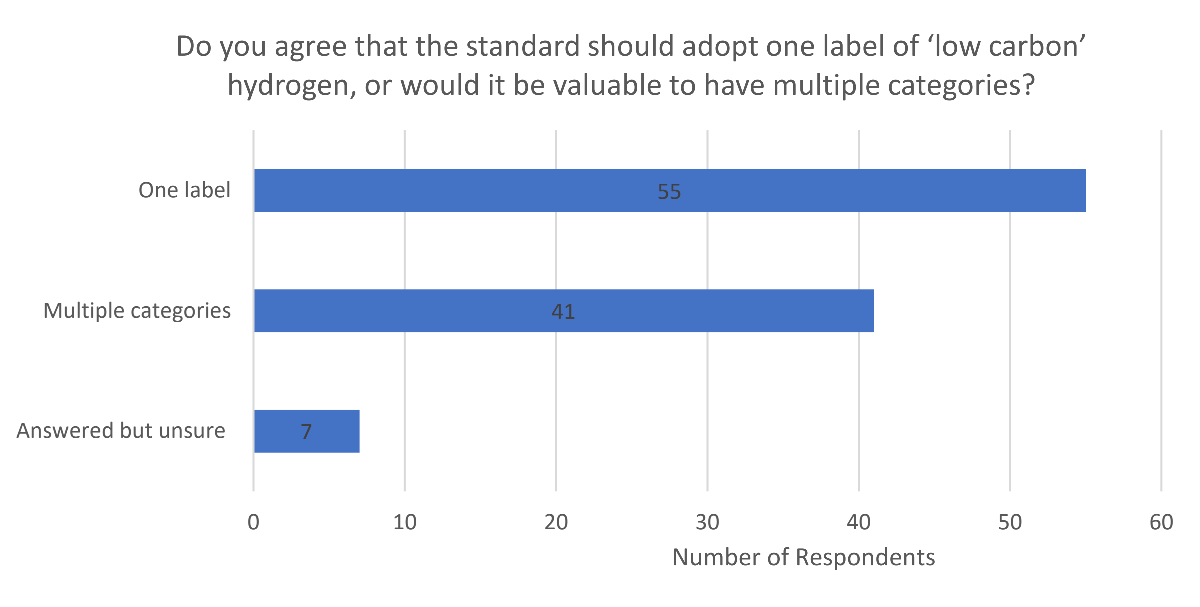
Our response

The design of the standard includes technology neutrality as a defining feature. Based on this, we modelled several production pathways to aid the design of the standard. Use of a particular pathway does not guarantee compliance, but each of the modelled pathways will be listed in the standard alongside methodology on how to calculate the GHG emissions. Guidance will then set out how producers can prove compliance with the emissions threshold as well as other requirements, such as the sustainability criteria.

Pathways not listed within the standard can also be compatible with the standard assuming they can prove they are able to meet the GHG threshold, the overarching LCA methodology and other requirements set out in the standard guidance. Projects with the required evidence of compliance with the standard should submit this to BEIS for analysis. Following sufficient scrutiny, we may then consider potential inclusion in future standard publications. To be considered for inclusion in the first standard review of the standard in early 2023, evidence should be submitted to hydrogenproduction@beis.gov.uk by 25/11/2022.The process will be laid out in the guidance document. Inclusion under the list of pathways does not mean projects will immediately be eligible for government support.

Q5a. Do you agree that the standard should adopt one label of ‘low carbon’ hydrogen, or would it be valuable to have multiple categories?
Q5b. If multiple categories, what benefits would we get from adopting this approach in terms of emissions reduction and consumer confidence?

Summary of responses



Just over half of respondents indicated that the standard should adopt one label of 'low carbon' hydrogen. Respondents also used the free text box in question 5b to comment, with the most common statement being that the standard should not bundle all production pathways into one "low carbon" label (32%). Transparency was the second most agreed upon viewpoint from 16 respondents (22%). A few respondents further added that transparency fosters investment and innovation into 'lower' carbon and GHG technology (11%), and a premium market could be developed for those wishing to pay for renewable zero carbon hydrogen (identified by 10% of respondents).

Other 'agree upon' justifications that were made by the survey participants have been gathered into themes in the Question 5 response themes table in Annex A.

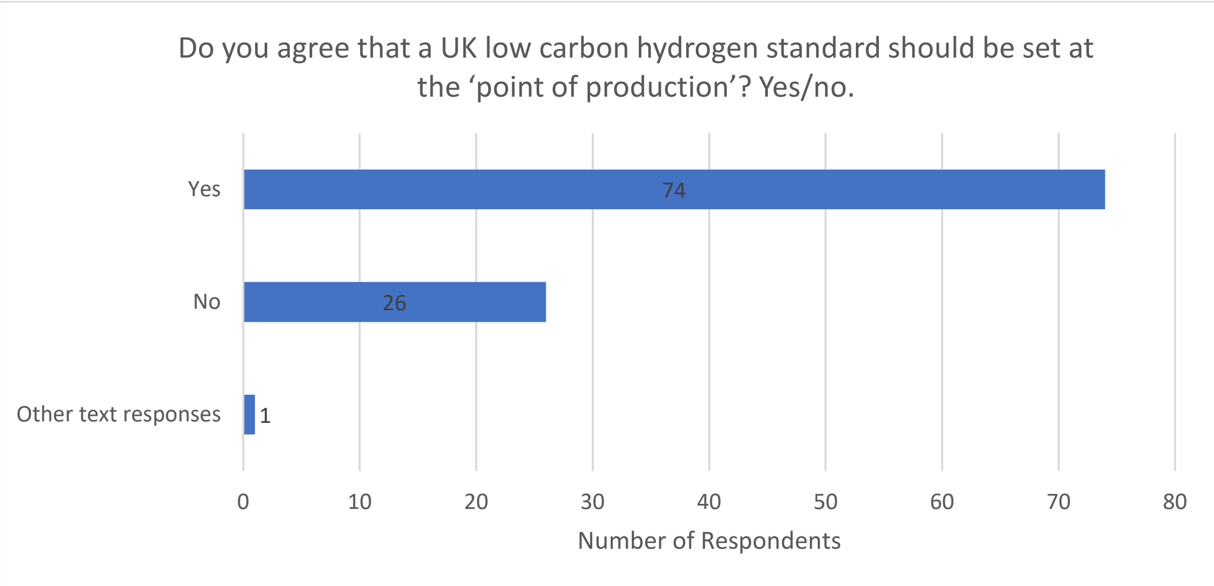
Our response

The standard will focus on the GHG emissions credentials of hydrogen production pathways and will support our pathway to net zero. Therefore, we consider one label for all low carbon hydrogen production methods capable of meeting the standard to be fair and simple. A few stakeholders suggested that disclosing further information on the production pathways may be beneficial to support consumer choice. As grading based on the carbon intensity of the hydrogen produced and multiple categories will be most relevant when thinking about developing the standard into a certification scheme, and the additional information customers might need, this will be considered in future. For example, electrolytic hydrogen projects that meet the RTFO requirements could be considered within the highest grade for electrolytic projects.

7.2. System boundary

Q6a. Do you agree that a UK low carbon hydrogen standard should be set at the 'point of production'? Yes/no.
Q6b. If no, what would the advantages be of the standard making assessments at 'point of use' or 'point of use + in use emissions'?

Summary of responses



The majority of respondents agree that the low carbon hydrogen standard should be set at point of production. Of the 74 'agree' answers, 6 respondents also elaborated and stated that any other approach would be too complicated. All respondents who disagreed with the standard being set at point of production provided comments with justification for the use of 'point of use'. The most common justification was that it would be a better representation of emissions within a product's lifecycle.

Further justification themes were noted in the agreement of point of use being applied by the standard in place of 'point of production'. These themes have been summarised in the Q6(b) response themes table in Annex A.

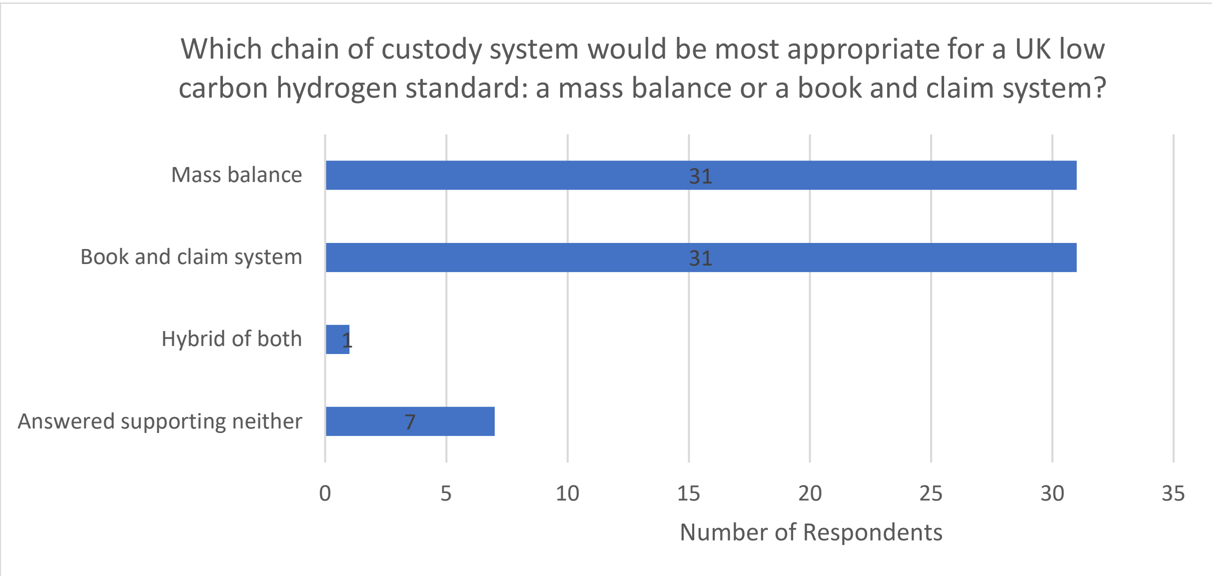
Our response

The standard will set a 'point of production' system boundary, which covers upstream emissions from the feedstock, such as natural gas, input materials, and emissions from the production process (including energy supply emissions). This maintains the focus of the standard on production, is simpler to implement than 'point of use', would have lower cost of compliance, and was supported by the majority of consultation respondents.

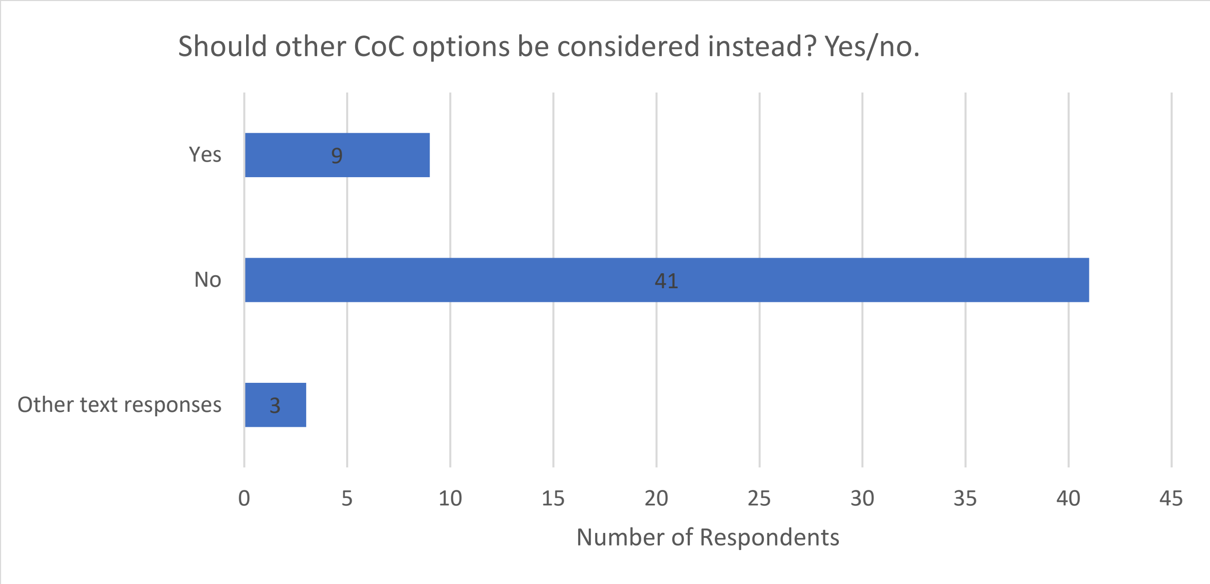
In future, to ensure any imported hydrogen was considered on an equal footing to domestic production, we would need to set the system boundary at point of import, allowing for the significant emissions used in the conversion/transportation process to be accounted for. We would expect this to fall under the administration of the certification scheme which we will be setting up by 2025. We will engage further with industry on this in due course.

Q7. Which chain of custody system would be most appropriate for a UK low carbon hydrogen standard: a mass balance or a book and claim system? Please explain the benefits of your chosen option.
Q8. Should other chain of custody options be considered instead? Yes/no. If yes, please provide detail.

Summary of responses



Respondents were divided on the best approach to take for chain of custody, evenly split between a 'mass balance' system (31) and a 'book and claim' system (31). More detail can be found in Q7(b) response themes table in Annex A.



Most respondents (77%) did not believe that other chain of custody options should be considered. No significant alternatives were provided, although nine comments were provided, and these are considered in the Q8 response themes table in Annex A.

Our Response

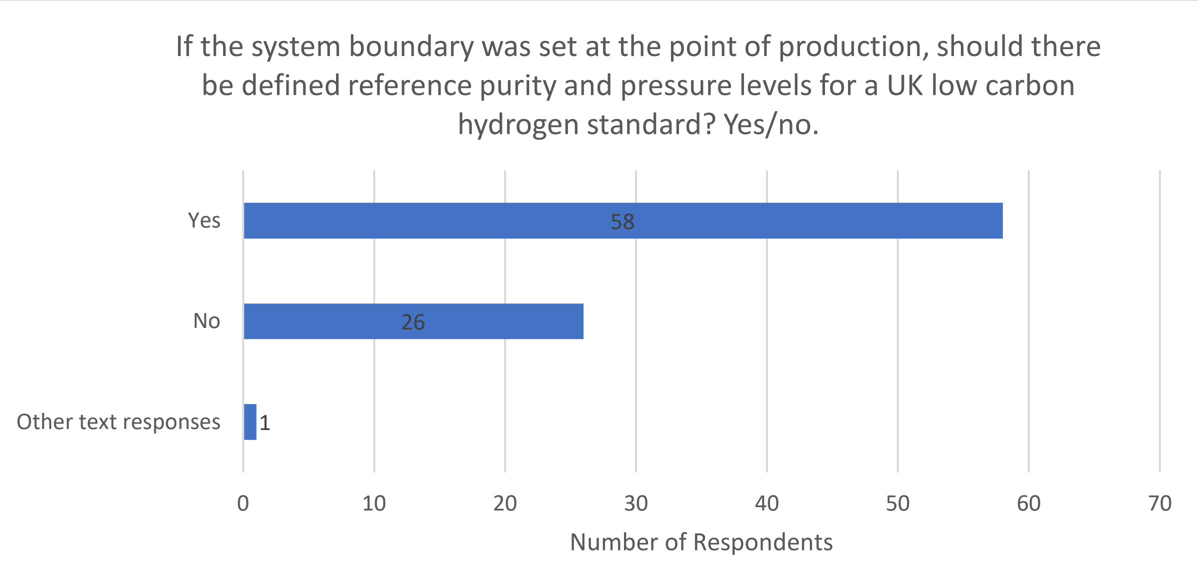
Chain of custody (CoC) requirements define how compliant hydrogen passes through the value chain until it reaches the end-user. CoC requirements should ensure sufficient traceability and transparency across the supply chain, while not adding unnecessary administrative efforts or costs for the operators implementing the standard. The standard guidance document will define what low carbon hydrogen is to the point of production. The chain of custody will become important when the hydrogen moves from the point of production into the value chain. Because of this the chain of custody will not be defined within the standard guidance.

The future certification scheme as set out in the Energy Security Strategy, may be introduced using the standard as eligibility criteria and the chain of custody will be an important defining feature. Based on the even split of respondents between 'book and claim' and 'mass balance' chains of custody and the complex interactions with other schemes, we will undertake further internal work and consultation to define the future certification scheme including establishing the best CoC to support the growth of the hydrogen market.

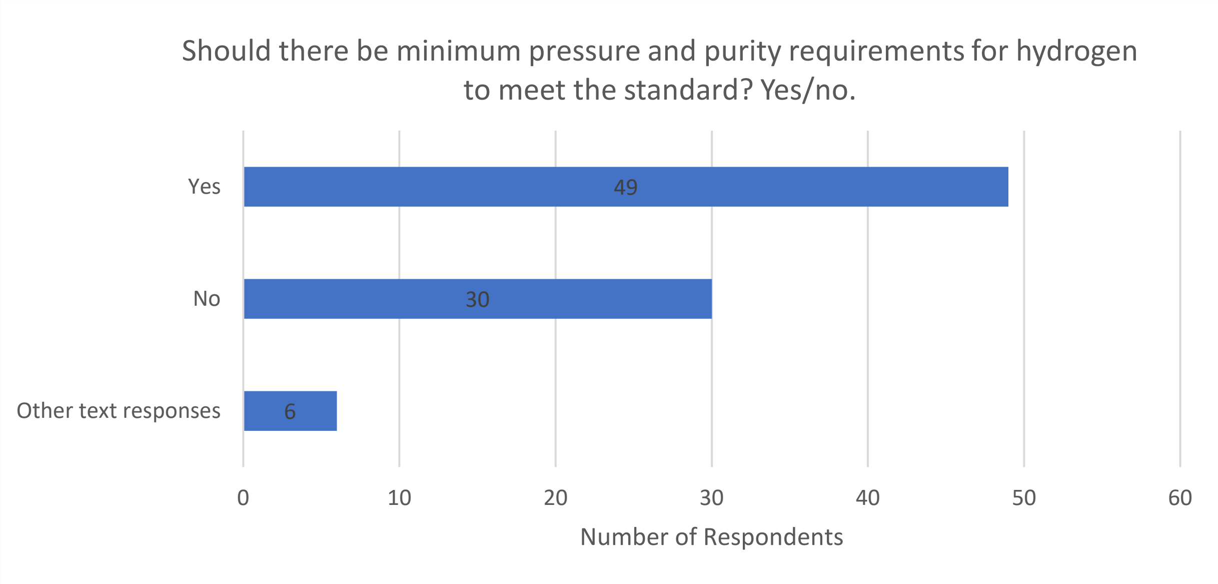
Q9a. If the system boundary was set at the point of production, should there be defined reference purity and pressure levels for a UK low carbon hydrogen standard? Yes/no.

Q9b. If yes, what should they be?
Q9c. If no, what are the benefits to not defining reference purity and pressure levels?
Q10a. Should there be minimum pressure and purity requirements for hydrogen to meet the standard? Yes/no.
Q10b. What could the potential implications of setting minimum purity and pressure requirements be?

Summary of responses



Over two thirds of respondents (68%) agree with the proposal to have a reference point for pressure and purity requirements for hydrogen to meet the standard. Further detail can be found in the Q9(b) response themes table in Annex A. The main response themes were that the standard should align with other international hydrogen standards (CertifHy & TUV SUD) and also that it should be taken into account that the pressure and purity requirements for the hydrogen produced will be different depending on needs of the end user. Responses to Q9(c) highlighted respondents' concerns on the impacts of setting a reference or minimum for pressure/purity including disadvantaging producers with lower pressure and purity end users, forcing hydrogen producers to invest in GHG emitting compression and purification that is not required and the importance of considering pressure and purity on an end-to-end basis.



Over half of respondents (58%) agree with the proposal to set minimum pressure and purity requirements for hydrogen to meet the standard. Further detail can be found in the Q10(b) response themes table in Annex A. The responses to this question raised concerns that lower pressure hydrogen could be disadvantaged while high purity hydrogen would be incentivised.

Our response

Compression and purification of hydrogen involves additional energy use and has associated emissions. With a production boundary set at point of production, it is important that the GHG emissions associated with compression and purification are accounted for in the reporting, and hydrogen producers are compared on a like-for-like basis.

We assessed four options: no reference, reference point, physical minimum, and theoretical minimum. 'No reference' has advantages in terms of reporting actual GHG usage but was discounted as low pressure and purity hydrogen would be unfairly advantaged and having no common point makes it difficult for the hydrogen producers to be compared at funding application stages. A reference point would require all hydrogen producers to do a theoretical calculation from actual pressure and purity to the reference point whether the actual value is above or below the reference. This results in some hydrogen producers being able to remove actual GHG emissions that are generated as they are theoretically reducing through this calculation, based on that the reference was also discounted. The third option is a physical minimum. Hydrogen producers above the minimum would be asked to report any actual GHG emissions related to their actual purification or compression processes without need for adjustment, however hydrogen producers below the minimum would have to compress or purify to meet the minimum. This is processing that may not be necessary for certain end uses and could create unnecessary emissions and cost for the producers.

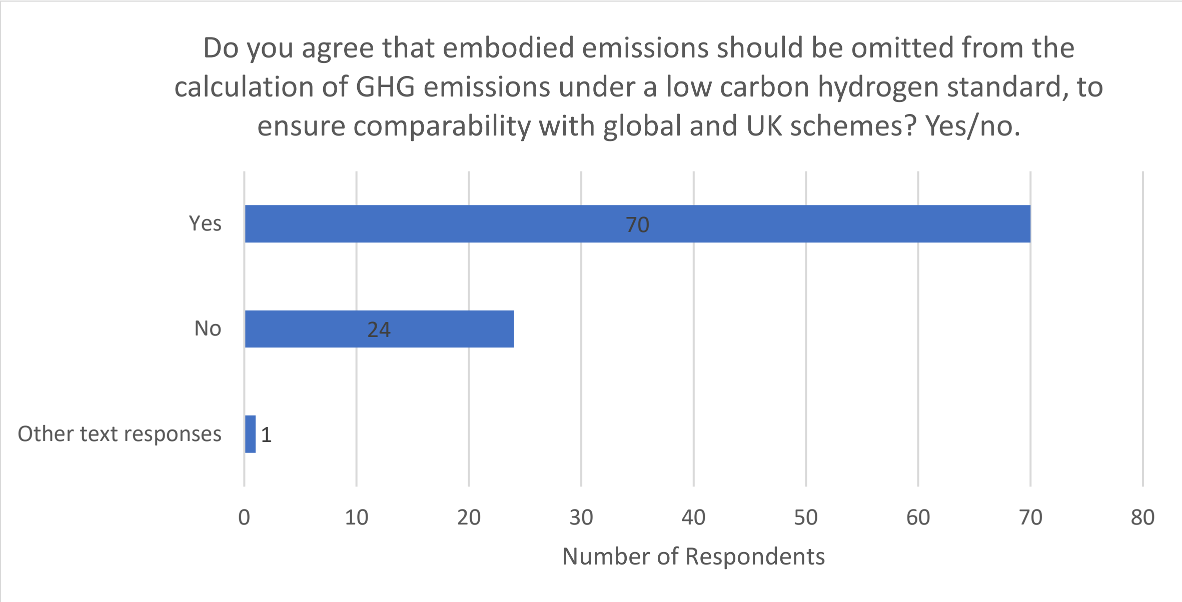
To enable the fair comparison of projects applying for funding we will define a theoretical minimum pressure and purity in the standard guidance. Compliance with the standard will not require actual compression or purification to a set point, this is to allow producers to agree specifications with off-taker(s) to facilitate multiple end uses. A hydrogen producer seeking to prove compliance with the standard having pressure and/or purity at or above the minimum values should include the actual GHG emissions associated with any compression or purification in their LCA. If a hydrogen producer has pressure and/or purity below the theoretical minimum then a calculation should be executed to calculate the GHG emissions associated with theoretical compression and/or purification to the theoretical minimum, the data required to do this will be provided in the standard guidance document.

The theoretical minimum for pressure will be set at 3MPa. It is unlikely that many hydrogen producers will fall beneath this pressure, therefore the majority of hydrogen producers will be required to report actual emissions associated with compression processes. The 3MPa value aligns with CertifHy and TÜV SÜD although it should be noted that TÜV SÜD has a physical minimum. The theoretical minimum for purity will be defined in the standard as 99.9%; hydrogen producers beneath this value will use the default data provided in the data annex to calculate and report the theoretical emissions associated with purification to 99.9%. Any hydrogen producer at a greater purity will report actual GHG emissions. 99.9% also aligns with CertifHy and TÜV SÜD, however for purity both schemes have a physical minimum so actual purification to 99.9% would be required to comply under these schemes.

The minimum theoretical pressure and purity will be used for the purpose of comparing hydrogen producers GHG emissions. The actual pressure and purity of the hydrogen produced should be agreed between the producer and off-taker(s).

Q11a. Do you agree that embodied emissions should be omitted from the calculation of GHG emissions under a low carbon hydrogen standard, to ensure comparability with global and UK schemes? Yes/no.
Q11b. If no, what are the benefits to including embodied emissions in the calculation of GHG emissions, and what should be done to ensure that hydrogen is on a level playing field to other energy vectors?

Summary of responses



Most respondents (74%) agreed that embodied emissions should be omitted from calculation of GHG emissions under a low carbon hydrogen standard. Of the 'disagree' answers, a third of respondents left comments suggesting the inclusion of embodied emissions would produce an accurate assessment of the full life cycle impact of hydrogen. A further 16% thought that including embodied emissions allows for accountability and transparency.

There are a number of other arguments made by the survey participants, which have been gathered into themes in the Q11(b) response themes table in Annex A.

Our response

The standard will not account for embodied emissions, although we may consider its inclusion in the future.

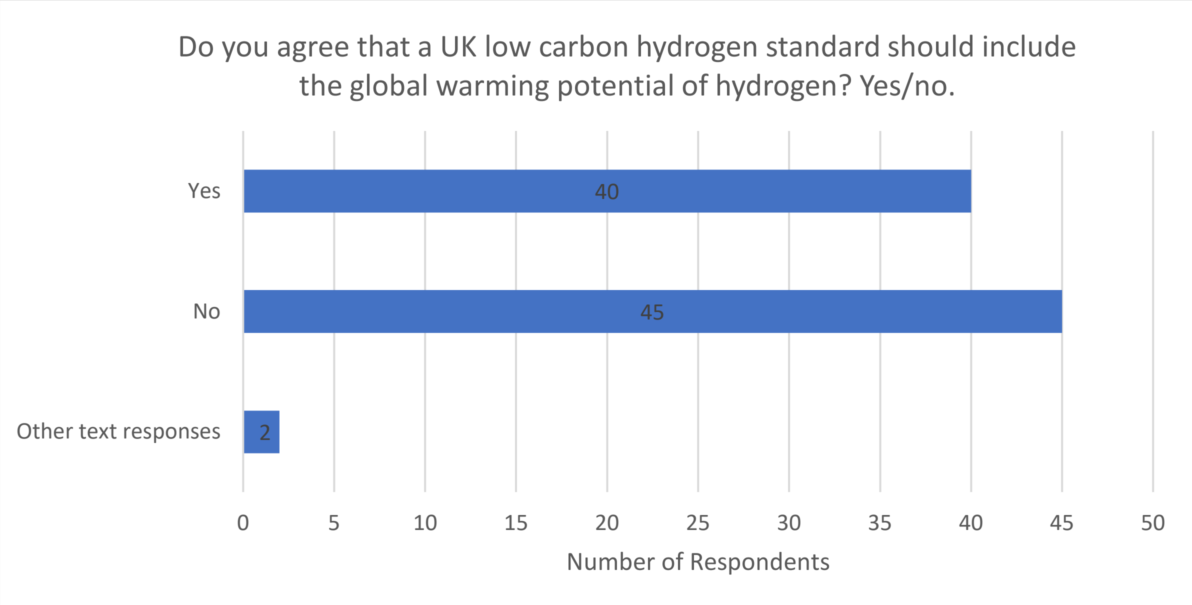
There is still a high level of uncertainty and reliability issues in the calculation of embodied emissions. Embodied emissions for other energy vectors are not currently fully accounted for in the UK's carbon budgets accounting, or other comparable global standards/schemes, although government does recognise that they contribute directly to global emissions. Excluding these emissions from the scope of the standard will ensure that low carbon hydrogen production is on a level playing field with other energy vectors and that the standard is in line with other international and national standards.

Respondents who were in favour of including embodied emissions highlighted the importance of providing a more accurate picture of the potential emission impacts of hydrogen. This is a position we are aware of, and BEIS is undertaking further work to improve the calculation of embodied emissions.

The decision to exclude embodied emissions will be reviewed as work on this topic progresses, and the standard could be updated to include embodied emissions in future to reflect improved evidence or a change in the UK or international context.

Q12a. Do you agree that a UK low carbon hydrogen standard should include the global warming potential of hydrogen? Yes/no.
Q12b. If no, are there other options for accounting for the GWP of hydrogen outside of a UK low carbon hydrogen standard that could support compatibility with existing standards/schemes?

Summary of responses



Consideration of whether to include the global warming potential of hydrogen (GWP) in the standard was closely split, with a slight majority of respondents (52%) not in favour. Of the 45 respondents that disagreed with the inclusion of GWP, 13 suggested that hydrogen's GWP is too uncertain and not clearly understood to include while eight suggested that hydrogen's GWP would be too complex to include or calculate. There were few suggestions for an alternative option for accounting for GWP, although some respondents suggested expanding other existing regulations.

Thirteen respondents that chose "No" to question 12a did not provide any further comment in response to question 12b.

Some justifications were made by respondents not to include the GWP of hydrogen, which have been gathered into themes in the Q12(b) response themes table in Annex A.

Our response

Based on the feedback received by stakeholders, and the fact that work is still ongoing to narrow uncertainties in the global warming impact of hydrogen and potential hydrogen leakage rates from production, the standard will not include a hydrogen GWP factor for now as part of emissions calculations.

BEIS has commissioned work from the University of Cambridge to understand the climate impact of hydrogen emissions using modern climate models[13]. This has reinforced the finding that hydrogen is an indirect greenhouse gas. Work is also ongoing to better understand where fugitive emissions stem from in the production process[14].

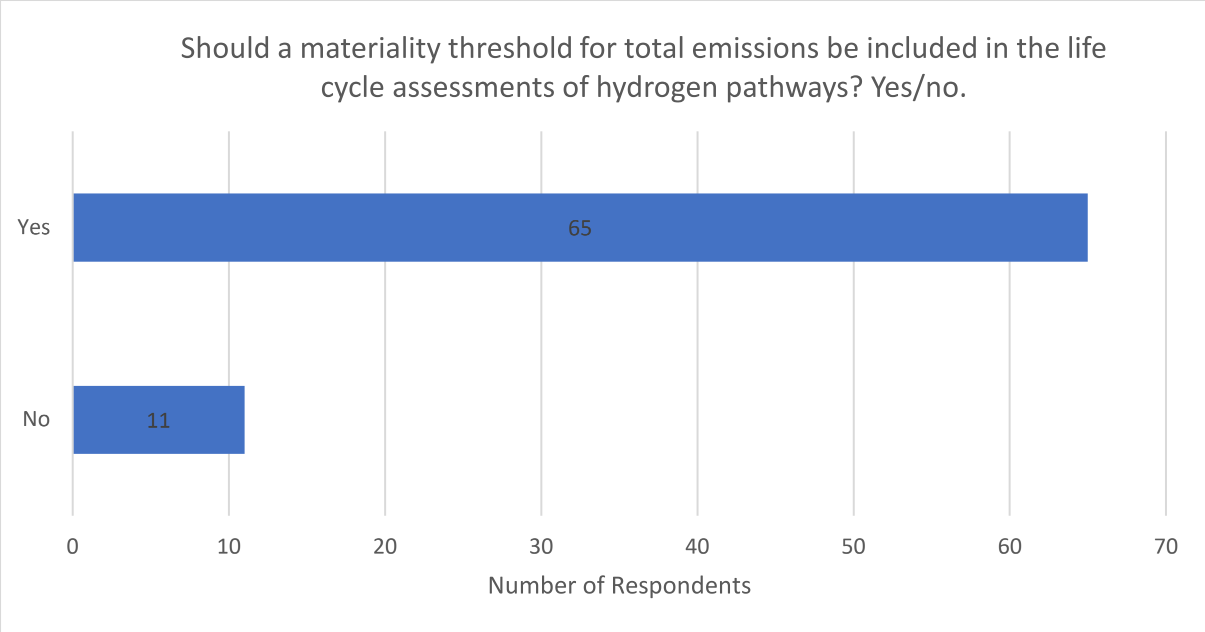
Based on these findings we are keen to ensure hydrogen producers and equipment manufacturers take every possible step to minimise the risk of fugitive emissions in the hydrogen production process. We will require producers to report their fugitive emissions, outside of the process to calculate LCA emissions, so that we can gather real-world data on how new low carbon hydrogen production plants operate during the early years of our government support schemes. This will help us understand the minimum level of fugitive emissions that can be achieved if appropriate mitigations are put in place.

We expect a GWP factor for fugitive emissions from hydrogen production to be included as soon as further evidence is gathered and a common position has been reached. We therefore expect hydrogen producers and equipment manufacturers to take all necessary measures to reduce any fugitive emissions associated with hydrogen production in anticipation of this next step.

Q13a. Should a materiality threshold for total emissions be included in the life cycle assessments of hydrogen pathways? Yes/no.
Q13b. If yes, what would the most appropriate level be and why?

Summary of responses

[13] https://www.gov.uk/government/publications/atmospheric-implications-of-increased-hydrogen-use
[14] https://www.gov.uk/government/publications/fugitive-hydrogen-emissions-in-a-future-hydrogen-economy



The majority (86%) of respondents think that a materiality threshold for total emissions should be included in the life cycle assessments of hydrogen pathways. Of those that responded to question 13a, 84% provided additional comment in question 13b. 91% of those responding with "Yes" provided additional comment and 36% of those responding with "No" provided additional comment.

The top five most reoccurring themes appear in the Q13(b) response themes table in Annex A.

Most respondents agree that a materiality threshold for total emissions should be included in the life cycle assessments of hydrogen pathways, with suggestions ranging between 0.2% and 5%; one respondent recommended it be between 5 and 10%. Two respondents said that the materiality threshold should be set in absolute terms (e.g., gCO_2e/MJ_{LHV}) to avoid imposing an administrative burden on very low carbon pathways to measure very small auxiliary inputs.

Of those responding "No" to question 13a, but still providing comment, the main theme was that adopting a materiality threshold could decrease the accuracy of reporting or encourage some to find loopholes in the standard.

Our response

A materiality threshold sets a percentage or absolute value of data that can be omitted from overall calculations. For the standard, this would relate to the recording of emissions through LCA to check compliance.

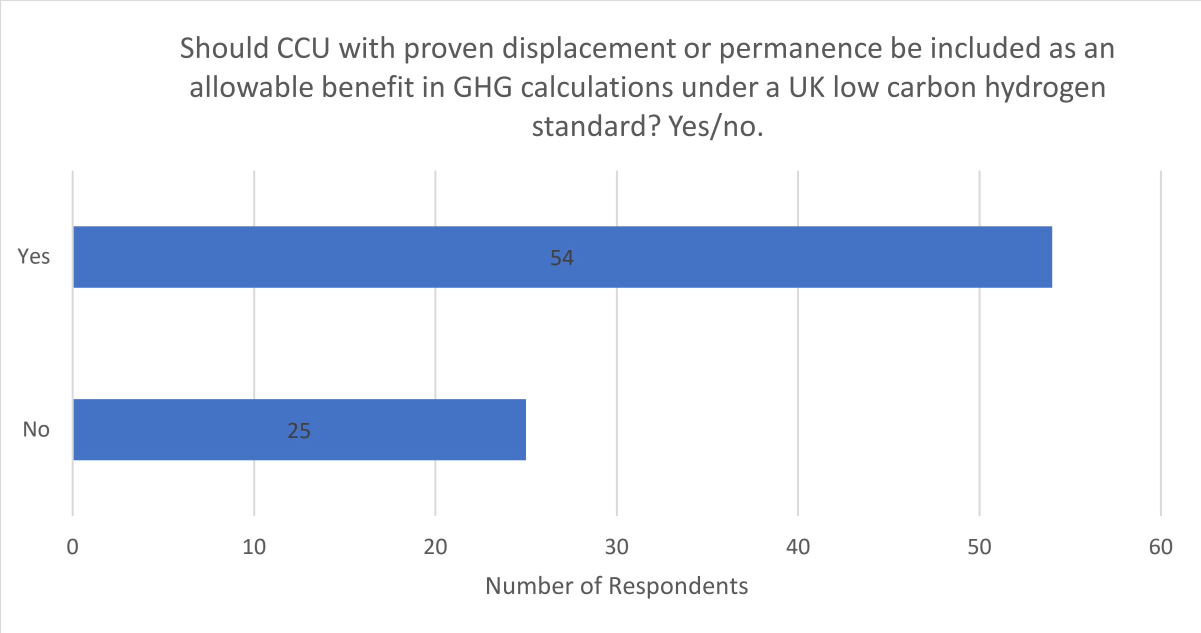
As part of our analysis, we assessed a materiality threshold in line with responses and other International and UK based schemes. Based on the production pathways to which the standard can apply we expect projects to be reporting a wide range of total GHG intensities: near zero emissions, near threshold emissions, and potentially negative emissions. Based on this a materiality threshold as a percentage of the GHG threshold would allow the largest emitters the most leeway in terms of the amount of data they could omit. Similarly, if the materiality threshold were set as a percentage or absolute value of the GHG emissions threshold, that could provide scope for the lowest emitting hydrogen producers to omit a level of data that could be of relative significance.

To utilise a materiality specification, the emissions from a particular source or activity would have to be quantified to ensure it was under the threshold. However, once emissions are quantified, most of the benefit of having a threshold is lost. In practice, a lack of data or the cost of gathering data may be a limiting factor, if individual material or energy flows are found to be disproportionally costly, or impossible to quantify for a particular unit process. Therefore, these may be excluded and shall be reported as data exclusions considering that if the actual data is known, then it should be included.

In the absence of a way to incorporate a materiality threshold that can apply equitably to all types of projects at varying levels of carbon intensity, the standard will not set a materiality threshold. Hydrogen producers demonstrating compliance with the standard are asked to report all data, and efforts must be taken to include all processes and flows that are attributable to the analysed system. Data omissions will be reviewed through annual audit and verification processes as part of ongoing compliance monitoring under the relevant government schemes. Once projects are operational, if significant evidence suggests that we should consider allowing regular omissions, a materiality threshold may be introduced in future.

Q14a. Should CCU with proven displacement or permanence be included as an allowable benefit in GHG calculations under a UK low carbon hydrogen standard? Yes/no.
Q14b. If yes, what should a suitable minimum time be for proven permanence and which applications should be eligible?
Q15. Should CCU credits only be allowed for biogenic carbon, and not allowed for fossil carbon sources? Yes/no.

Summary of responses

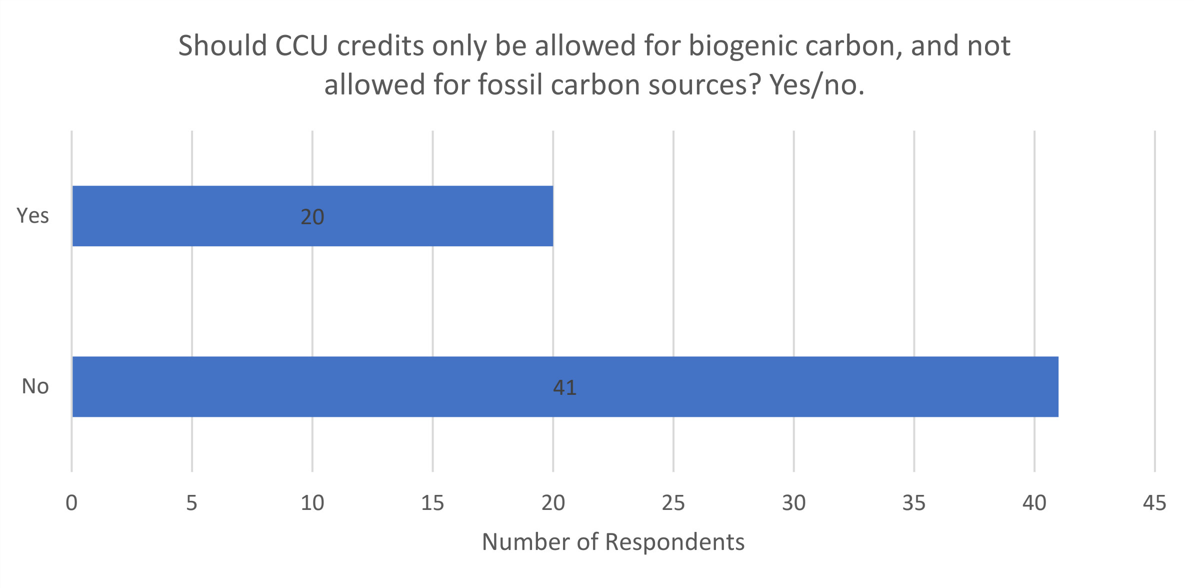


The options we set out in the consultation document were as follows:

- CCU should be included only with proven displacement of CO_2 from fossil origin, potentially with additional rules about this fossil CO_2 having previously been purposely generated (to ensure fossil fuels are being displaced).
- CCU should be included only with proven permanent abatement of CO_2. For this option, clear rules need to be set as to the minimum time before the carbon can return to the atmosphere.
- CCU should not be given any credit.

68% of respondents agree with the proposal of including CCU with proven displacement or permanence as an allowable benefit in GHG calculations under a UK low carbon hydrogen standard.

Some comments received on this question suggested that only CCU which leads to permanent abatement should be eligible. Further suggestions include that regulations and work on CCU are needed to ensure it meets green standards. Three respondents suggest that CCS does not allow for emissions elimination and therefore it cannot benefit GHG calculations. Only five respondents provided an indication of time for proven permanence, although this ranged from 100 years to a period of 10,000 years.



Our response

As there is no commonly adopted method for the treatment of CCU and no consistent rules for CCU in international standards, further analysis will be required to develop a robust methodology to account for the emissions reduction potential of CCU. The overall emissions reduction benefits of utilising as opposed to storing carbon depend on the length of time that carbon remains 'locked in' to its point of use. For example, carbon used in fizzy drinks is released as soon as the can or bottle is opened, whereas carbon in construction materials such as cement is likely to be locked in for a far greater period. The uncertainty surrounding this topic was underlined by the lack of consistent evidence presented by respondents to this question, and the wide range of years that respondents considered appropriate to prove permanence (from 100 to 10,000 years).

The UK low carbon hydrogen standard will therefore not give carbon captured and utilised (CCU) any credit in this first iteration of the standard. This means that carbon captured and utilised will be considered as emitted for the purpose of GHG emissions calculation in the standard. We will consider further evidence in this area as it develops and will keep CCU accounting under review.

7.3. Energy inputs/feedstock emissions

Q16. As the grid is decarbonising rapidly, so will grid connected hydrogen production pathways. How should government policy take into consideration hydrogen production pathways using grid electricity as primary input energy now? Please explain the benefits to the approach you have suggested.

Q17a. What options should we consider for accounting for the use of electricity under a UK low carbon hydrogen standard? Do the options outlined seem appropriate? Are any of these particularly problematic? Please explain your reasoning.
Q17b. Of the options considered, should further conditions be included to mitigate any negative impacts or potential unintended consequences, such as driving additional high carbon power generation, and what could these conditions be?
Q18. What evidence should BEIS consider ahead of making decisions around the use of electricity as primary input energy for hydrogen production?

Summary of responses

The main observation across responses to Question 16 is that a flexible approach to supporting electrolytic hydrogen production is needed while the hydrogen market grows. The majority of respondents favoured allowing the use of market-based measures such as Power Purchase Agreements (PPAs) alongside Guarantees of Origin, underpinned by a clear threshold and methodology to track the source of emissions in the electricity used. Responses also highlighted the need to allow flexibility across a range of different low carbon electricity inputs, ensuring rules are not overly burdensome but balanced against the need to ensure the credibility of the standard is maintained through a robust threshold.

Question 17 comprises four distinct sub-sections. To present the submitted information clearly, the responses to the above questions were condensed into two analyses – the accounting options deemed ‘appropriate’, and the options considered ‘problematic’. This method of analysis was chosen because of very frequent crossovers in the responses.

The main observation from the 71 responses to the questions above is that electrolysers should be able to connect to the grid under flexible conditions. The stated conditions varied between answers. The most common responses highlighted that a system involving grid-connected electrolysis combined with PPAs and temporal correlation could be an effective solution, although specific suggestions for methodologies and accounting methods to achieve this differed.

Of respondents that set out that the options put forward were appropriate, a significant number of respondents (44%) favoured allowing electrolysers to connect to the grid. However, many of these respondents remarked that electrolysers should be constrained during times at which grid carbon intensity is high in order to ensure the hydrogen produced meets any agreed low carbon threshold. On temporal correlation, a number of respondents favoured the use of the half-hourly meter readings generated by electrolysers for precision monitoring of GHG emissions. Several respondents also advocated allowing the use of regional grid carbon intensity as an accurate measure of geographical correlation between generation and consumption.

Of respondents that identified specific challenges with options that were proposed, a third of respondents considered only allowing physical links to be particularly problematic. This is due to the co-location limitations, which were deemed restrictive in nature. A smaller proportion of respondents (20%) highlighted the administrative challenges that a temporal correlation requirement may bring for hydrogen producers, and the lack of consistency with other sectors, such as buildings and electricity users. Further challenges were identified with additionality requirements being a barrier to hydrogen deployment, and traded activities alone allowing the use of the grid at times of high carbon intensity.

On question 18, the main observation from the responses was that there were several opposing views, with some respondents indicating that a flexible approach to utilising electricity from the grid was essential for early sector growth. Others disagreed, suggesting that only 100% renewable sources should be used, and that the standard should show rigidity. On specific evidence considerations, respondents made suggestions such as carbon intensity associated with the electricity supply and implementing requirements such as the use of Power Purchase Agreements. These broadly matched comments from questions 16 and 17.

Further detail of the themes mentioned in the consultation are outlined in the relevant tables in Annex A.

Our response

Low carbon hydrogen produced via electrolysis is only as low carbon as the electricity used to produce it, and we have considered all available options for how the use of low carbon electricity should be accounted for and the evidence that is required to prove that the electricity comes from a low carbon source.

As highlighted by respondents, the grid will not be sufficiently decarbonised to meet the standard threshold consistently until at least the 2030s without further conditions, such as the use of market-based mechanisms like Renewable Energy Guarantees of Origin (REGOs) and Power Purchase Agreements (PPAs). These market-based measures provide some assurance that grid imported electricity used in hydrogen production is low carbon. However, we recognise that these measures may not be sufficient in all cases to guarantee the low carbon nature of the electricity used in hydrogen production. For example, without further conditions the existing REGO based annual retrospective renewable energy matching may not reflect the actual carbon content of the electricity used in real time.

The standard will therefore define three technical requirements for low carbon electricity input that must be met to by hydrogen producers seeking to demonstrate compliance with the standard:

- Energy attribute information – to demonstrate exclusive ownership of the attributes of the low carbon electricity used.
- Low carbon electricity generation attributes – to prove links to low carbon electricity input – e.g. the hydrogen production facility has entered into a Power Purchase Agreement, has purchased low carbon wholesale electricity or has other contractual information to prove links to the electricity attributes of the low carbon source.
- Temporal correlation – to prove time-based links between generation and hydrogen production consumption.

These technical requirements allow for accurate accounting of the low carbon nature of electricity used. The accompanying standard guidance document provides further detail on the evidence required to prove these have been met, including frequency of reporting and the types of data that will be required to prove ongoing compliance with the standard for funding via NZHF and HBM schemes.

To ensure accurate reporting of GHG intensity of hydrogen produced using electricity, all electricity inputs will be measured as discrete consignments [15]over 30-minute electricity settlement periods, and any use of grid imported electricity will need to be measured using real time national grid average carbon intensity data, matched to time of hydrogen production.

For electrolytic hydrogen producers using a mixture of electricity inputs (e.g. wholesale grid imported electricity and direct connected low carbon generation), the standard will permit the use of either: i) discrete consignments from a single measurable input; or ii) averaged consignments based on the average of multiple discrete consignments (allowed once in a calendar month provided within the standard threshold). Further detail is provided in the standard guidance document.

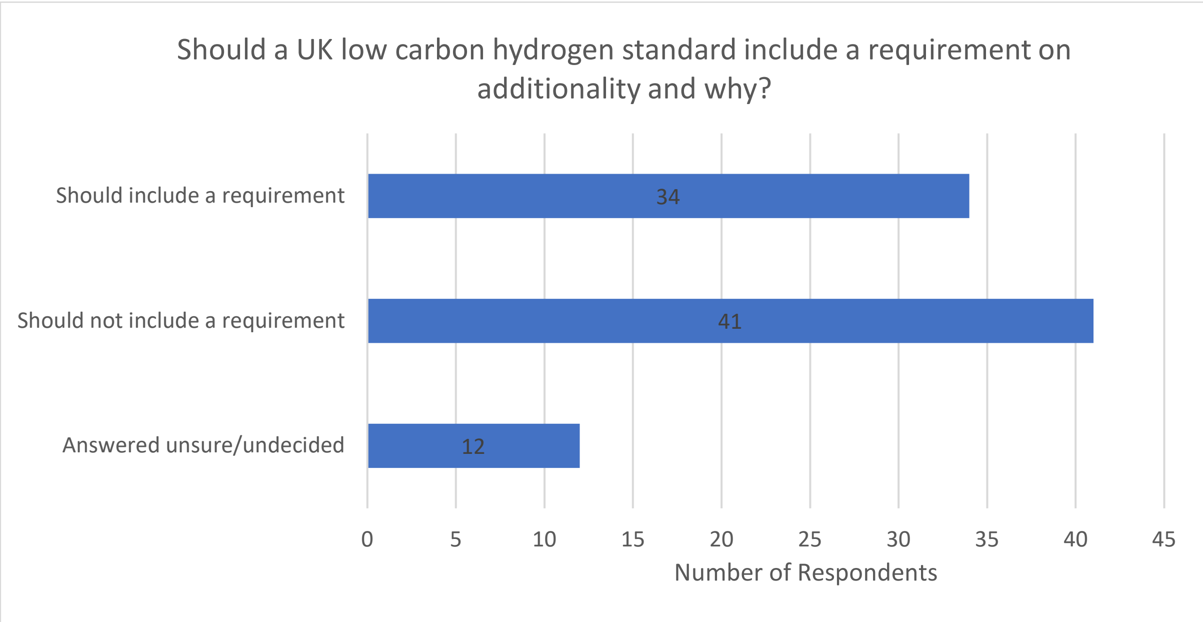
Further incentives for the lowest possible emission electrolytic hydrogen production may be provided through the design of the evaluation criteria for the 2022 HBM / NZHF electrolytic allocation round and through the future certification scheme design.

[15] A discrete consignment is made with a single input and the hydrogen output will have an identical set of environmental characteristics; as set out in the standard guidance document.

We will continue to assess the impact of electrolysers on the broader energy system and will keep our approach under review to ensure it remains fit for purpose.

Q19. How should low carbon electricity use in hydrogen production be accounted for in order to support the deployment of hydrogen production via electrolysis, whilst avoiding unintended consequences such as increased generation from high carbon power sources (impacting grid decarbonisation)?
Q20. Should a UK low carbon hydrogen standard include a requirement on additionality and why? Please explain the benefits to the approach you have suggested.

Summary of responses



Views on whether to include an additionality requirement or not were split, with a slight preference among respondents for not including it (47%). The main themes of responses are highlighted in the Q20 response themes table in Annex A.

From the comments gathered in question 19, the main observation was that most respondents (67%) suggested mandating additionality would not be compatible with development of the hydrogen economy, as it would constrain the development of new hydrogen production. Concerns were raised that an additionality requirement would increase costs around hydrogen production and hamper the rollout of low carbon hydrogen, especially at a time of new market development. Some respondents also noted that hydrogen should not be responsible for the development of new low carbon generation, and instead government should seek to deploy new low carbon generation to meet the demands of the energy transition.

Our response

We recognise that there are demonstratable benefits to linking electrolytic hydrogen production to new build or life-extended low carbon generation, especially where this is unsubsidised by government support schemes (such as the Contracts for Difference), and that these types of projects should be incentivised and rewarded. Projects that can meet additionality principles are likely to provide significantly lower emissions from a power system perspective as they avoid diverting electricity from other users. They also support deployment of new distributed low carbon generation. We also recognise the benefits of seeking to promote and incentivise the use of excess or curtailed electricity, which we deem should also be considered 'additional' for hydrogen production, irrespective of support schemes, as it would not otherwise have been utilised if it were not used in hydrogen production. Electrolytic projects that meet either of these additionality principles will likely be the highest grade from an emissions perspective, and as such may also be eligible for renewable end use support schemes such as the Renewable Transport Fuel Obligation (RTFO).

We will therefore incentivise and reward projects that meet our additionality principles through allocation of HBM and NZHF support. Projects that meet these principles for additionality will substantively improve their overall scoring when applying for funding through these schemes.

However, we do not think an additionality requirement mandating that hydrogen production be limited to new build, life-extended generation or curtailed electricity should be a requirement in the standard at this initial stage. In making this decision we have sought to strike a balance between ensuring lowest possible emissions and encouraging growth of a new sector. We are mindful that we need to grow the hydrogen economy rapidly to deliver large scale emissions savings in end use sectors in the longer term. We will keep this under regular review to ensure our position remains appropriate facilitates economy-wide decarbonisation, supporting schemes such as the RTFO. We would expect these reviews to coincide with future hydrogen business model allocation rounds, and as a minimum would occur no less frequently than every two years.

We have developed a set of additionality principles that may apply to specific assessment criteria for Government funding.

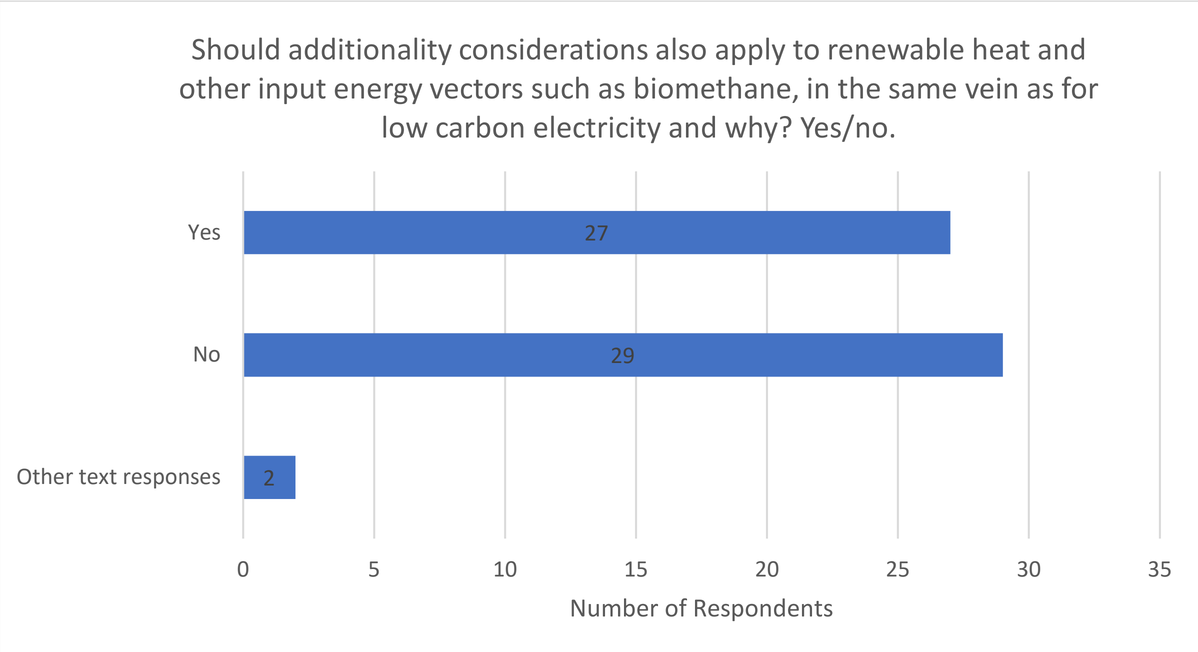
Principles for Additionality

Principle	Rationale
1. Electricity supplied by new/recently built low carbon generation assets, built (or partially built) without securing a Government support contract (e.g. Renewables Obligation /Contract for Difference)	- This electricity would not otherwise have existed or been available for the grid if not for the hydrogen production, meaning it can be deemed ‘additional’ and won’t be diverting electricity from other users.
2. Excess electricity which would have led to curtailment or been wasted if not consumed by the hydrogen producer	- This electricity would otherwise been wasted, and is therefore ‘additional’.
3. Electricity provided by low carbon assets that are life extended to facilitate (fully or partly) hydrogen production (where hydrogen production can be evidenced to have been a decisive factor in life extension)	- This electricity would not otherwise have existed or been available for the grid if not for the hydrogen production, meaning it can be deemed ‘additional’ and won’t be diverting electricity from other users.
4. Electricity supplied by low carbon assets that are recommissioned, (where hydrogen production can be evidenced to have been a decisive factor in recommissioning)	- This electricity would not otherwise have existed or been available for the grid if not for the hydrogen production, meaning it can be deemed ‘additional’ and won’t be diverting electricity from other users.

Therefore, using these principles, BEIS will seek to incentivise hydrogen producers that can demonstrate they have built or funded new low carbon generation, or are utilising curtailed electricity, through allocation of HBM and NZHF support. For example, for the evaluation stage of the 2022/23 HBM and NZHF electrolytic allocation round, we are proposing that an additionality evaluation criterion is included to consider these principles, so that, if the principles for additionality can be met, a project can improve their overall scoring. Further details on this proposal can be found in the HBM and NZHF electrolytic allocation market engagement document. We will review this approach for future funding rounds. The application rounds for NZHF-only support will also incentivise additionality via the assessment process. Full details on the allocation rounds, the additionality principles, and the evidence required to demonstrate these have been met will be set out in relevant application guidance documentation.

Q21. Should additionality considerations also apply to renewable heat and other input energy vectors such as biomethane, in the same vein as for low carbon electricity and why? Yes/no. Please explain the benefits to the approach you have suggested.

Summary of responses



There was no clear consensus as to whether additionality considerations should also apply to other input energy vectors, in the same way as for low carbon electricity.

A range of recommendations and suggestions were made by respondents, which have been gathered into themes in the Q21(b) response themes table in Annex A. The most common responses called for consistency in approach between low carbon electricity and other input energy vectors (24%) and, echoing responses to Q20, suggested that an additionality requirement would add unnecessary constraints to the deployment of low carbon hydrogen (19%).

Our response

Additionality measures have rarely been considered in other hydrogen or energy-related standards for input energy vectors beyond low carbon electricity. For the majority of these inputs, we are not aware of a clear rationale for additionality measures under the standard. We plan to keep this under review as new evidence emerges and the hydrogen economy matures.

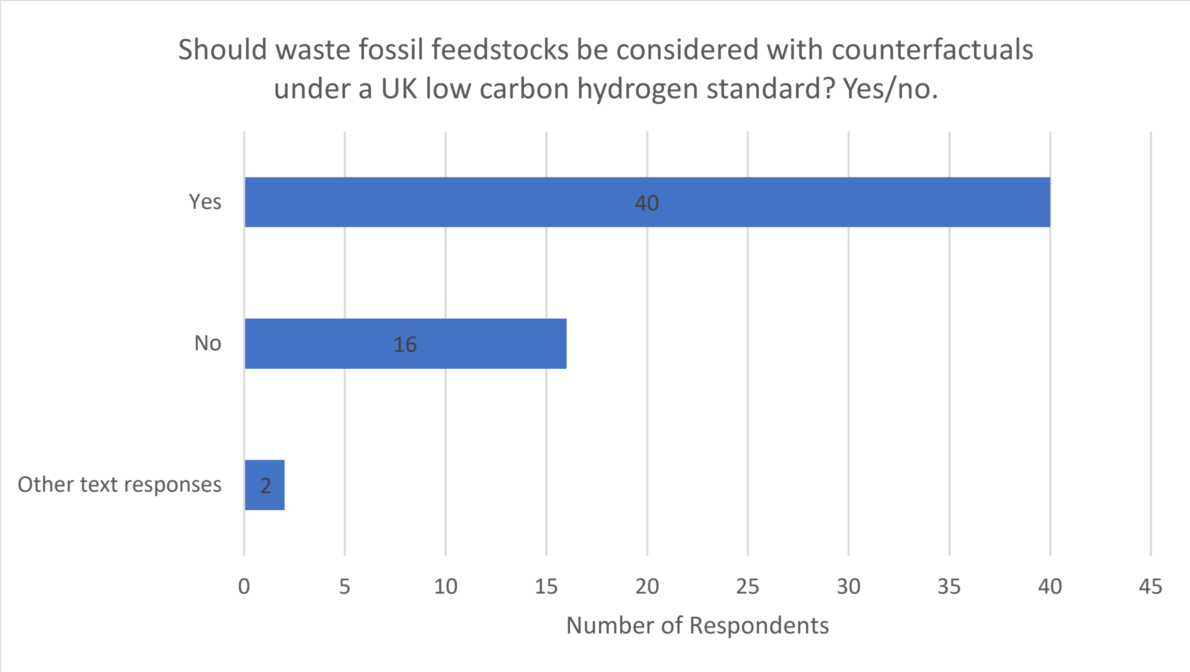
However, there is a comparable situation between low carbon electricity and biomethane use as an input for hydrogen production. Biomethane (and the feedstock from which it is produced) is a limited resource, which will likely deliver greater GHG savings when used directly in other areas of the energy system (e.g. for the near-term decarbonisation of heating). Furthermore, if the biomethane used in hydrogen production is not replaced by further biomethane production, it may cause the use of more fossil gas for heating, negating some or all of the GHG benefit enabled by the biohydrogen production.

In line with our response to Q20, and respondent requests for consistency across feedstocks, the standard will not include any requirements for hydrogen producers to use biomethane inputs that are "additional". BEIS may however seek to incentivise hydrogen producers that can demonstrate additionality for biomethane inputs, where funding is made available to this production route through the allocation processes of the HBM and NZHF.

Full details on the evidence required to demonstrate additionality will be set out in relevant application guidance documentation. We will continue to review this position at set review points to ensure it remains consistent with our broader decarbonisation policies.

Q22a. Should waste fossil feedstocks be considered with counterfactuals under a UK low carbon hydrogen standard? Yes/no. Please explain the benefits to the approach you have suggested.
Q22b. What are the potential implications of supporting the use of any particular waste streams in hydrogen production?

Summary of responses



Less than half of all respondents replied to this question. Of those that did respond, most thought that waste fossil feedstocks should be considered with counterfactuals under a low carbon hydrogen standard. Nine comments referred to the benefit of using counterfactuals in promoting the circular economy and supporting the waste hierarchy. Eight responses suggested that the counterfactual system should be aligned with other existing schemes, especially with the Renewable Transport Fuel Obligation (RTFO) methodology.

16 responses (28%) were against the idea of introducing counterfactuals for waste fossil feedstocks. Reasoning for this focussed around two main themes: the complexity that counterfactuals present, and that waste fossil feedstocks are fossil fuels and need to be treated that way.

All the themes that have been extracted from the responses are shown in the Q22(a) response themes table in Annex A.

Only 38 responses were received to Question 22(b) with a majority of respondents raising possible inadvertent negative impacts of supporting particular waste streams. It was rare that specific waste streams were mentioned – when they were, most often the example of plastic was provided. The range of responses received meant only three specific themes were identified for this question, gathered in the Q22(b) response themes table in Annex A.

Our response

As reflected in multiple consultation responses, fossil waste to hydrogen technologies could contribute to the government's objectives of promoting a circular economy. To ensure this benefit, hydrogen produced from fossil waste and supported by the government will need to adhere to the waste hierarchy, in line with existing waste regulations. The principal aim of the standard, however, is to ensure that hydrogen production supported by the government schemes and policies that apply the standard is low carbon. Evidence presented alongside the initial consultation[16] suggests that in the absence of a counterfactual approach, the use of fossil waste without carbon capture and storage would not be compliant with the standard.

There was widespread support across responses for the inclusion of counterfactuals when accounting for the use of fossil waste feedstocks in hydrogen production. However, in the absence of a widely accepted methodology for considering counterfactuals, respondents also raised the desire for a consistent approach with that proposed by the Department for Transport (DfT) for recycled carbon fuels under the RTFO. This approach is still under consideration following consultation but we will seek alignment wherever possible.

Given the carbon impacts of allowing fossil-based feedstocks, the lack of clear precedent to follow and the complexity of the issue, at this stage we will not account for fossil waste feedstocks with counterfactuals. Fossil waste will therefore be treated in the same way as other fossil-based inputs such as oil or natural gas. This decision will be reviewed as appropriate in light of further evidence, analysis and ongoing work across government on the best accounting methodology to take forward.

Q23. What is the most appropriate way to account for hydrogen produced from a facility that has mixed inputs (high and low carbon)? Please explain the benefits to the approach you have suggested.

Summary of responses

Of the 74 responses to the consultation, some form of averaging was recommended by 53% of respondents; the main reasons for this were transparency and flexibility. There was a slight preference among respondents for averaging across all consignments as the most appropriate way to account for hydrogen produced from a facility with mixed inputs, out of the three options specifically mentioned in the consultation document:

- Averaging across all consignments (so all hydrogen produced has the same GHG emissions intensity and must meet the GHG set).

[16] Options for a UK low carbon hydrogen standard: https://www.gov.uk/government/publications/options-for-a-uk-low-carbon-hydrogen-standard-report

- Separate consignments (with potentially different GHG emissions). For example, if an electrolyser has 60% low carbon electricity, 40% high-carbon electricity inputs, the operator may be able to claim 60% low carbon hydrogen, 40% high-carbon hydrogen, or vice versa.
- Separate consignments but with averaging – separate consignments are used but the average emissions of all consignments also need to meet a benchmark figure (e.g., in CertifHy, the annual average needs to be below a 'benchmark' steam methane reforming (SMR) figure of 91gCO_2e/MJ_{LHV}).

Averaging across all consignments was mentioned by 30% of respondents, separate consignments with averaging by 23% of respondents, and separate consignments by 19% of respondents.

There are several key themes which became evident after review of the participant's responses. These are summarised in the Q23(a) response themes table in annex A.

Our response

The standard will allow both discrete and averaged consignments. A discrete consignment is made with a single input and the hydrogen output will have an identical set of environmental characteristics as set out in the standard guidance document. Single inputs would be considered as: e.g. a low carbon electricity source compliant with the low carbon electricity principles, biomass compliant with the biomass sustainability criteria and minimum waste and residue requirement, natural gas, grid electricity or waste with a measured fossil and biogenic content and its use compliant with the waste hierarchy. All inputs will need to be evidenced with metering and upstream emissions and sustainability criteria compliance accounted for.

Averaging will also be allowed within the standard; this allows multiple discrete consignments to be averaged. Averaging can be used for discrete consignments that are made using the same input to account for variability in the upstream GHG emissions. There will be a maximum defined time period for consignments as defined in the guidance document. Averaging cannot be used to offset hydrogen production above the threshold using negative emissions processes. Further details on acceptable averaging is laid out in the guidance document. For each defined time period producers will be allowed to produce a mix of discrete and averaged consignments to prove compliance with the standard.

Hydrogen producers will be expected to provide transparency about which consignment method is used, through self-reporting of consignments for compliance according to the relevant scheme rules. For hydrogen producers looking to comply with the RTFO, only discrete renewable consignments will be eligible (note there are other RTFO rules which must also be complied with), and DfT would only consider the biogenic fraction of a mixed waste feedstock.

The discrete and averaged consignment approach is designed to support the ambitious growth targets of the nascent hydrogen market by permitting the mixing of low carbon and higher carbon inputs, delivering a balance between transparency, flexibility and overall GHG emission reduction. As the hydrogen market becomes established and wider decarbonisation is achieved, we may review the ongoing need for both consignment options.

7.4. GHG methodology and threshold

Q24. What are the most appropriate units to calculate GHG emissions of low carbon hydrogen?

Summary of responses

The main observation drawn from the 76 responses is that the majority of respondents (74%) are in agreement that the most appropriate unit for calculating GHG emissions of low carbon hydrogen is in gCO_2e/MJ_{LHV}. All other suggestions are each under 10% of responses. These main themes are summarised in the Q24 response themes table – units suggested in Annex A and are then split into sub-themes to highlight the most common justifications for the recommendations.

Our response

Whilst some respondents proposed to use gCO_2e /kgH_2, a large majority favoured using gCO_2e/MJ_{LHV} to calculate GHG emissions of low carbon hydrogen. Almost all existing standards such as CertifHy or TÜV SÜD use gCO_2e/MJ_{LHV}.

In the consultation document, we set our minded to position to use gCO_2e/MJ_{LHV}. Considering consistency with other schemes as well as the response from industry, we confirm that gCO_2e/MJ_{LHV} will be used to calculate GHG emissions of low carbon hydrogen in the standard. We will provide conversion tables to HHV, kWh and kgH_2 in the standard guidance document.

Q25. What allocation method should be adopted for by-product hydrogen and why?

Summary of responses

There was no strongly preferred option in the responses to the consultation document, with the largest individual responses from the 52 responses indicating that either an energy-based (17%) or system expansion allocation (12%) should be adopted for by-product hydrogen. However, 10% of respondents suggested that a single allocation method is not suitable and alternative methods should be incorporated and considered on a case-by-case basis. More detail can be found in the Q25 response themes table in Annex A.

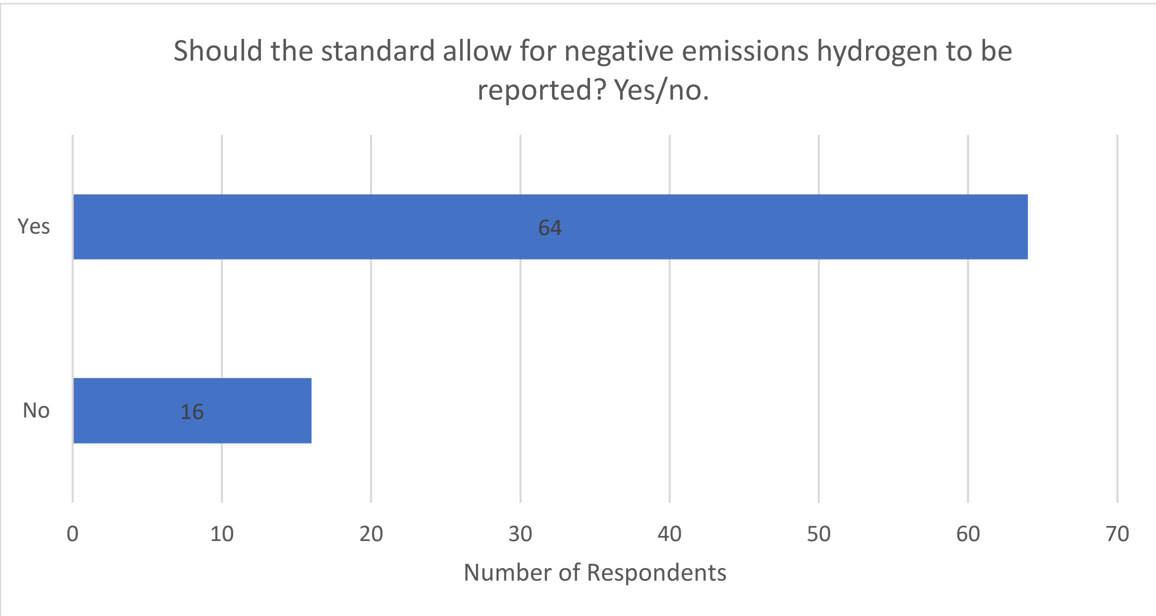
Our response

The methodology for calculating emissions associated with by-product hydrogen will not be included in this iteration of the standard. Further work has been undertaken and the government will continue to gather evidence to inform a decision on the appropriate allocation method for by-product hydrogen. By-product hydrogen may be included in future iterations of the standard when that work has been completed.

The standard strives to treat all production pathways equally, based on GHG emissions intensity, and allocation methods will be considered if by-product hydrogen is introduced in future iterations of the standard. The government notes the preferences expressed in the consultation responses and will conduct further work in the UK and in collaboration with international partners to ensure a coherent framework for reporting emissions from hydrogen produced as a by-product of an industrial process.

Q26. Should the standard allow for negative emissions hydrogen to be reported? Yes/no.

Summary of responses



Question 26 was a yes/no only question, with no opportunity for written responses or comments. Most respondents were in favour of allowing negative emissions hydrogen to be reported.

Our response

In line with the strong support from respondents, it will be possible to account for and report negative emissions under the standard. Negative emissions can only be claimed under the standard where they are genuine (meaning the permanent storage of captured biogenic CO_2 or of CO_2 captured from ambient air) and directly related to the hydrogen production process (i.e., carbon credits cannot be taken or purchased from a separate process to offset emissions under the standard). Similarly, if any unit of negative emission from a hydrogen production process is claimed elsewhere, it cannot also be claimed under the standard. Further details are provided in the standard guidance document. Hydrogen producers demonstrating compliance with the standard will be able to report negative emissions where they meet the standard guidance.

This decision is consistent with UK and international accounting norms and reflects actual decreases in atmospheric CO_2 due to the hydrogen production process.

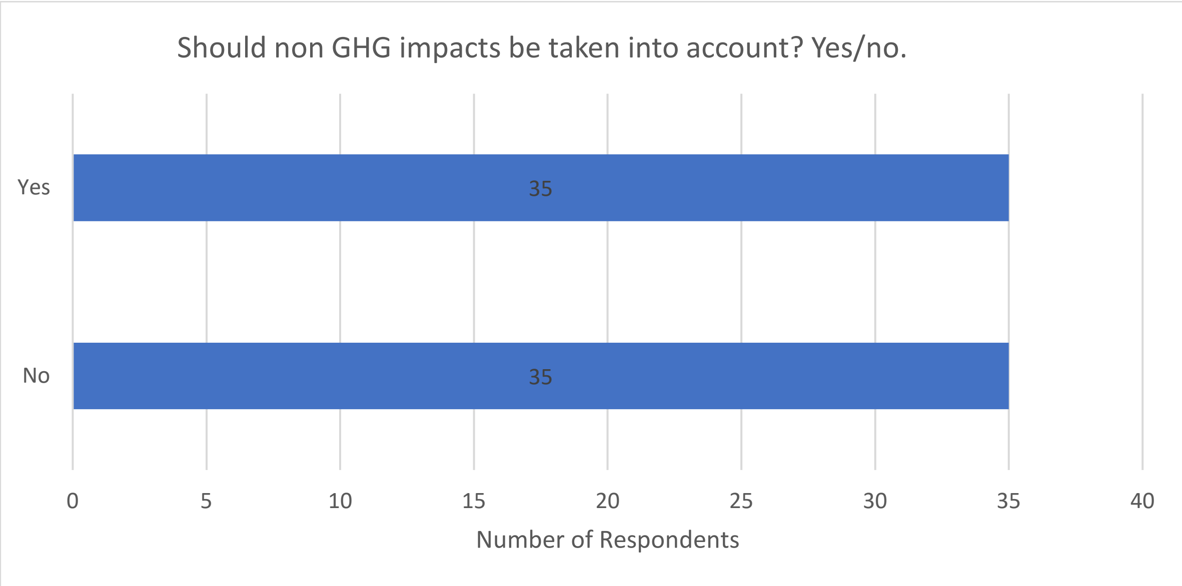
The Government plans to consult on business models for engineered Greenhouse Gas Removals (GGRs) in 2022. This will set out details of our preferred mechanisms to incentivise early investment and enable commercial demonstration of a range of GGR technologies from the mid-to-late 2020s. This will be followed by the Biomass Strategy later this year. These policy developments may hold implications for the treatment of negative emissions in hydrogen policy, for example:

- The introduction of measures to limit emissions from a biomass-based hydrogen production pathway that can, in effect, be offset by negative emissions associated with that pathway.
- Ensuring alignment between the objectives of biomass and GGR policies and those of hydrogen policy.

Where appropriate, the standard will be updated to reflect these changes.

Q27a. Should non GHG impacts be taken into account? Yes/no.
Q27b. If yes, what criteria or factors should be taken into account and how?
Q27c. If no, please set out your rationale for your answer.

Summary of responses



There is no clear consensus among respondents, with half of respondents agreeing that non-GHG impacts should be considered within the standard and half disagreeing.

Of the 35 respondents agreeing, 91% left comments suggesting factors or criteria to be considered. Numerous non-GHG impacts were discussed in the responses, which are summarised in the Q27(b) response themes table in Annex A.

Of the 35 respondents disagreeing, 89% left further comments expanding their choice. The main consensus was that there is no requirement to include non-GHG impacts as these are already covered by existing policies and regulations and could overcomplicate the standard. The key themes established from these responses are summarised in the Q27(c) response themes table in Annex A.

Our response

The standard is predominantly focused on GHG emissions associated with hydrogen production, but a range of non-GHG issues were mentioned by respondents and we consider that further consideration of these issues within the standard is appropriate.

- Biomass Sustainability

For the use of biomass as bioenergy, it is important that sustainability criteria (beyond GHG emission thresholds alone) are in place to avoid adverse environmental and social consequences. Sustainability criteria are found across schemes that can promote biomass use (e.g., RTFO, Green Gas Support Scheme) or previously have done so (e.g., Renewable Heat Incentive, Renewables Obligation).

The standard will also include sustainability criteria, where biomass is used as a feedstock for hydrogen production. As far as possible, these are consistent with existing policy precedents:

- GHG criteria: for non-waste and non-residue biomass feedstocks, indirect land use change (ILUC) emissions will need to be reported on the basis of default values. These emissions will not be included in the overall lifecycle emissions. This is in line with the current RTFO approach to ILUC emissions. Otherwise, no further amendments are necessary to the methodology and threshold set out for all other hydrogen production pathways in the standard guidance document.
- Land and other criteria: these will follow the criteria set out under the RTFO (e.g., land criteria, forest criteria, soil carbon criteria). Further details can be found in the standard guidance document.

To encourage the use of waste and residue biomass feedstocks, and minimise risks associated with direct and indirect land use change, the standard follows the precedent set by the GGSS (and the RHI) by requiring that at least 50% of hydrogen (by energy content) from biogenic feedstocks is produced using wastes or residues. Further details of this requirement can be found in the standard guidance document.

- Other non-GHG impacts

Outside of the development of the standard we continue to consider and assess a range of non-GHG impacts, and we are closely engaged across government and with wider stakeholders on these issues.

As part of the Hydrogen Strategy, we committed to continue to consider the wider environmental impacts of different methods of hydrogen production, such as resource requirements for land or water, or any potential changes in soil, water or air quality.

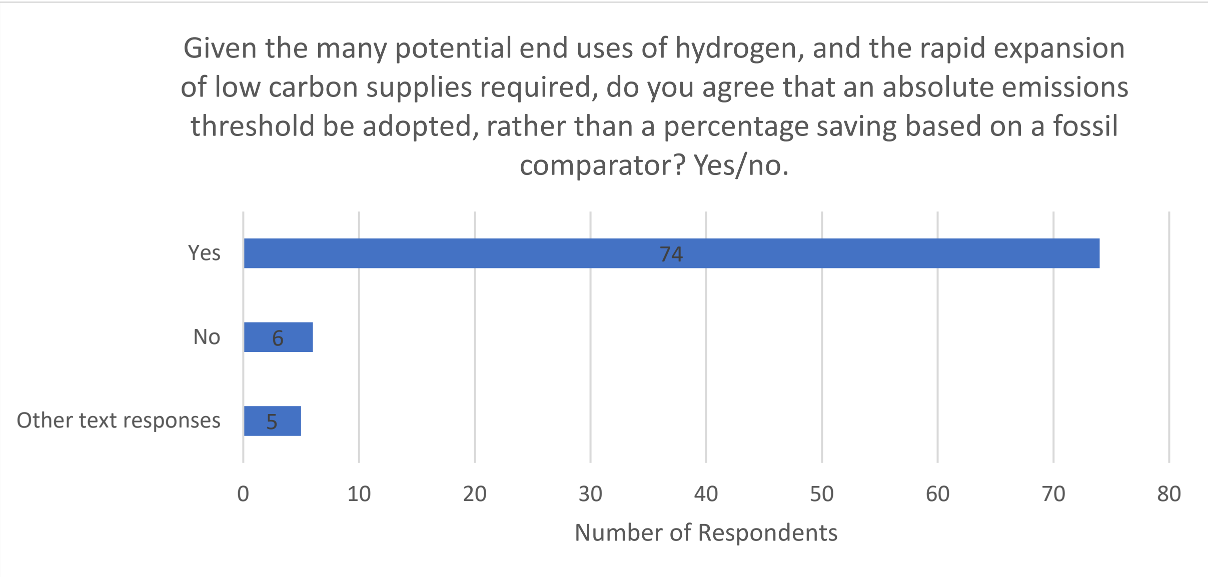
The production of hydrogen is likely to need significant amounts of water and, together with industry, we are continuing to engage with the Environment Agency, regional water resources groups and water companies to ensure appropriate plans are in place for sustainable water resources. We are conducting further analysis on water resource requirements for hydrogen production this year and will continue to work across key stakeholders to identify the key challenges around resources, quality and regulations.

On air quality, we are continuing to build our evidence base on emissions through the combustion of hydrogen, and how best to mitigate any risks. BEIS has funded work under the Hy4Heat and Industrial Fuel Switching programmes assessing the extent of nitrous oxide (NOx) production in a range of hydrogen appliances, and considering how appliances can be designed to minimise NOx. Work within the 'Climate Services for a Net Zero Resilient World[17]' research programme will also review the possible air quality impacts of hydrogen use in certain combustion applications.

7.5. GHG threshold

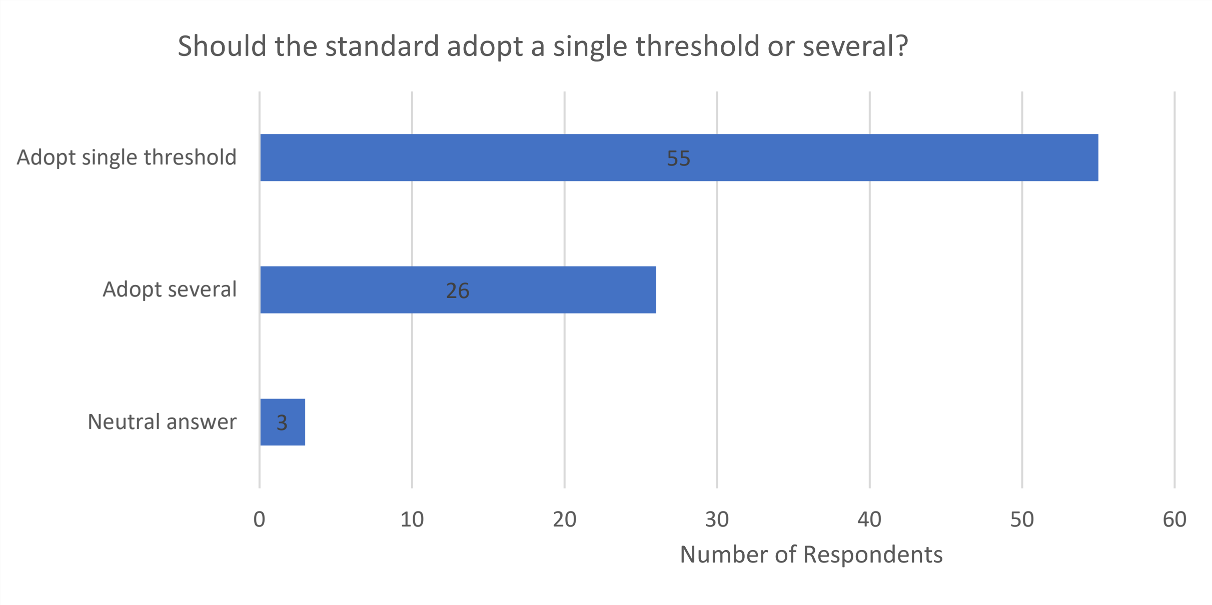
Q28. Given the many potential end uses of hydrogen, and the rapid expansion of low carbon supplies required, do you agree that an absolute emissions threshold be adopted, rather than a percentage saving based on a fossil comparator? Yes/no. Please provide detail.
Q29. Should the standard adopt a single threshold or several, and why?

Summary of responses



The vast majority of respondents (87%) agreed that an absolute emission threshold be adopted. 92% of responses included further details and comments, which have been categorised into the different themes in the Q28 response themes table in Annex A.

[17] https://www.gov.uk/government/publications/climate-services-for-a-net-zero-resilient-world/cs-n0w-overview



Approximately two thirds of respondents preferred the option of adopting a single threshold with the most common reason being simplicity. Just under a third of respondents were in favour of adopting several thresholds, while just three respondents adopted a neutral position.

Comments made by the survey participants have been gathered into themes in the Q29 response themes table in Annex A.

Our response

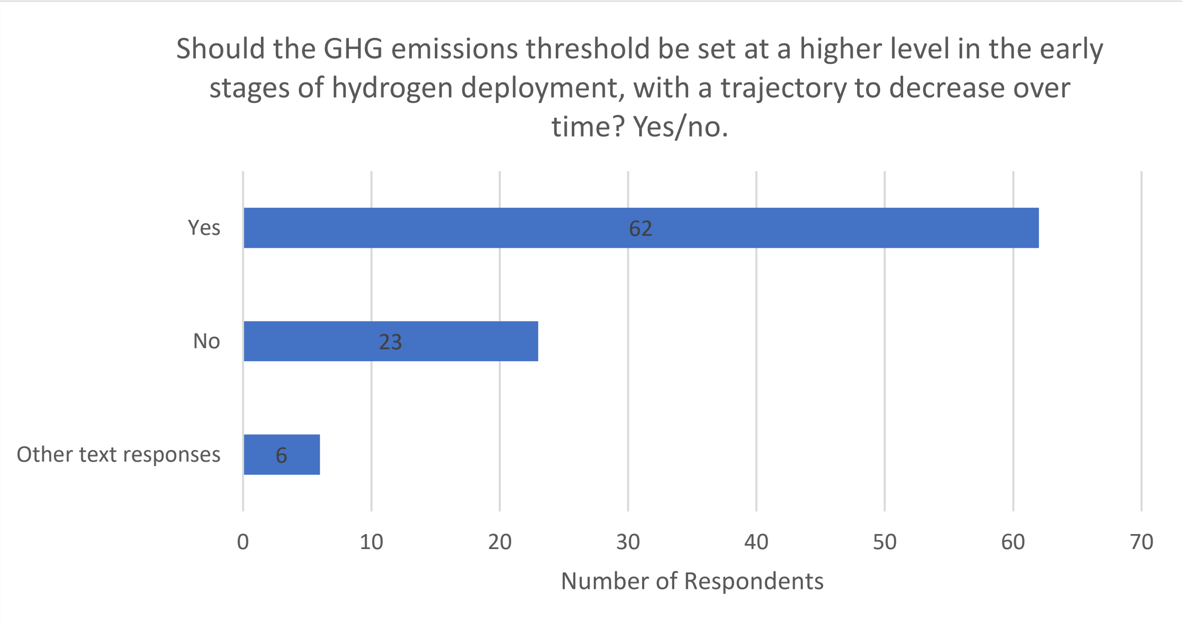
The main objective of the standard is to make sure the hydrogen production initially supported through government schemes and policies that apply the standard, and in future in the wider industry, is sufficiently low carbon to make a significant contribution to our carbon budget targets and net zero commitments. To ensure transparency and fairness, while the UK low carbon hydrogen production market is developing, the standard will adopt one absolute threshold for all hydrogen producers looking to demonstrate compliance with the standard.

Some stakeholders suggested that additional grading and disclosing further information on the carbon intensity of the pathways may be beneficial to support consumer choice. This is relevant when thinking about developing the standard into a certification scheme, and the additional information customers might want as part of this. The carbon intensity levels of different production pathways will be therefore considered in future, as the certification scheme is developed.

Q30a. Should the GHG emissions threshold be set at a higher level in the early stages of hydrogen deployment, with a trajectory to decrease over

time? Yes/no. Please explain the benefits to the approach you have suggested.
Q30b. If yes, should this decreasing trajectory be announced from the offset? Yes/no. Please explain the benefits to the approach you have suggested.

Summary of responses



The majority of respondents (68%) agree that a higher emission threshold should be set in the early stages, with a trajectory to decrease (tighten) over time. There are a number of key themes which became evident after review of the participant's responses. These are summarised in the Q30(a) response themes table in Annex A.

Of the 65 responses to Q30b, 74% stated that they agree to the decreasing trajectory being announced from the offset while 23% disagreed. The key themes from within the responses are shown in the Q30(b) response themes table in Annex A.

Our response

We expect to tighten the standard over time, in line with government's trajectory to net zero. Given that there is very little low carbon hydrogen currently in production in the UK (less than 5MW), we will need time to understand how the standard will work in practice as the market develops. We therefore do not propose setting out the trajectory for the threshold at this stage.

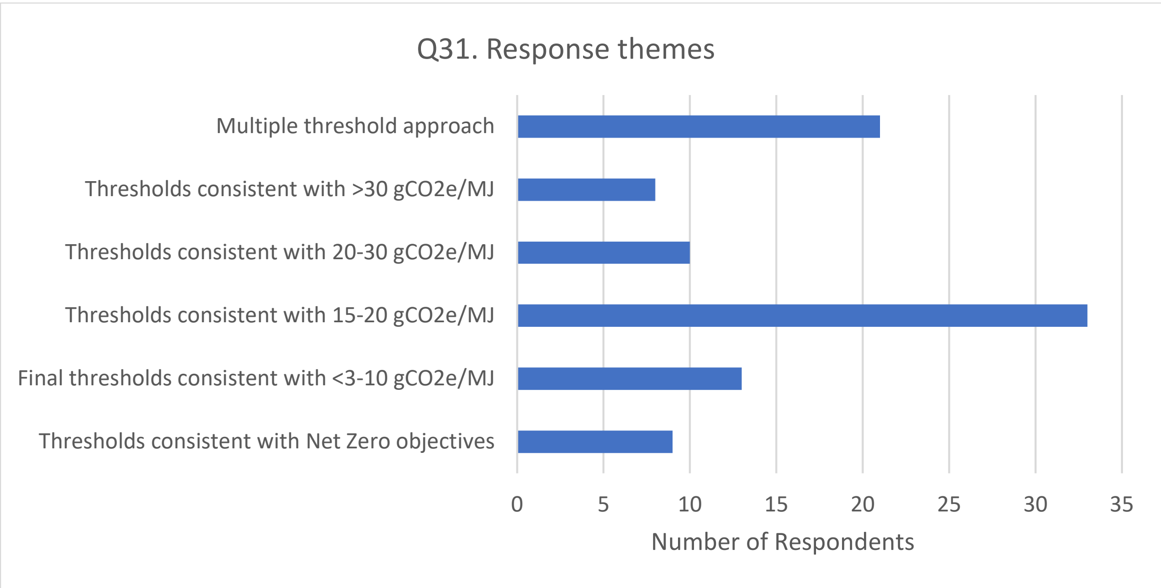
In setting the threshold, BEIS sought to strike a balance between ensuring lowest possible emissions and encouraging growth of a new sector, mindful that the greatest benefits will come from the 2030s onwards when deployment is achieved at a significant scale.

As the electricity grid decarbonises, it is expected that emissions from hydrogen production pathways using significant grid electricity inputs, such as CCS-enabled hydrogen from auto-thermal reformation and grid electrolysis will decrease further by 2030. See the report on 'Options for a UK Low Carbon Hydrogen Standard'[18] for further detail on emissions projections throughout the years.

We propose that review points for the standard could coincide with future funding rounds (e.g., further rounds of HBM support) where required, but BEIS would not expect any future changes to the standard to apply retrospectively to contracts that have already been awarded.

Q31. What would be an appropriate level for a point of production emissions threshold under a UK low carbon hydrogen standard? Please set out your rationale for your answer.

Summary of responses



There were mixed views on this question, although the highest proportion of respondents (43%) agreed with a point of production emissions threshold within a

[18] https://www.gov.uk/government/publications/options-for-a-uk-low-carbon-hydrogen-standard-report

range of 15-20gCO_2e/MJ_{LHV}, although this with some caveats in the accompanying comments. Other respondents were split between both higher and lower thresholds, with the next highest group (27%) suggesting a multiple threshold approach.

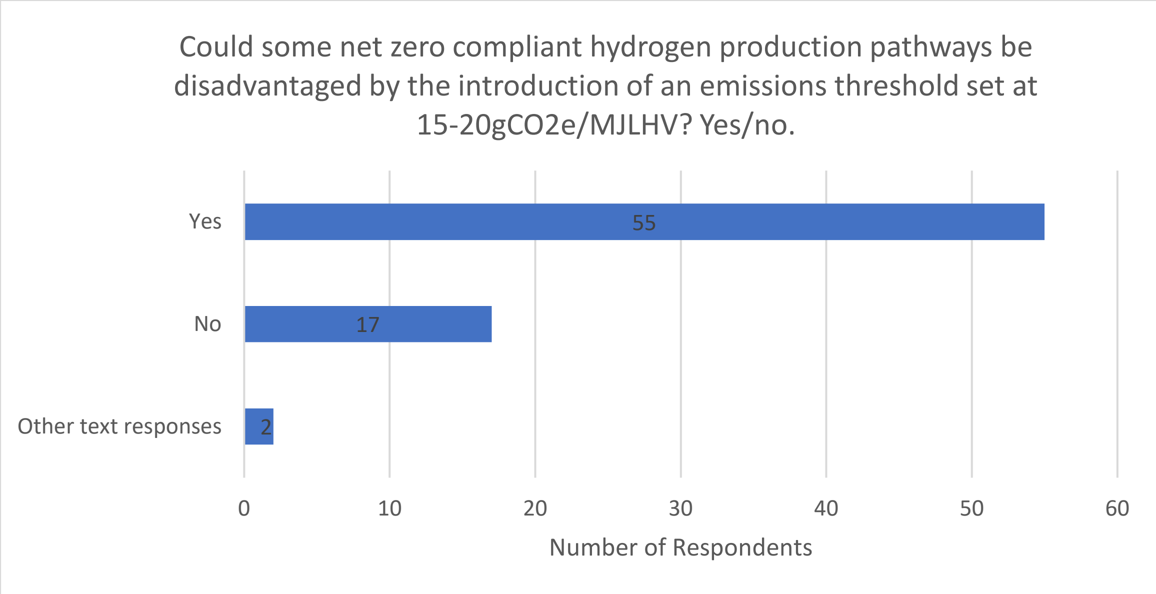
While 10% proposed initial thresholds of 30gCO_2e/MJ_{LHV} or above, these were highly dependent on the use of carbon capture and storage technologies being able to bring emissions down to at least 5 gCO_2e/MJ_{LHV} by 2050, which was viewed as uncertain by 6% of respondents. Further detail can be found on responses themes to question 31 in Annex A.

Our response

The standard will establish a 20gCO_2e/MJ_{LHV} hydrogen threshold for low carbon hydrogen, which could result in 76% emissions saving compared to current fossil-based ‘grey’ hydrogen or around 61% emissions saving compared to burning natural gas. Based on the responses to the consultation and our internal analysis of the project pipeline, we consider this level strikes the right balance between limiting emissions at an individual project level and enabling growth of the hydrogen economy needed to achieve net zero. We consider this threshold will best support our ambition of up to 10GW hydrogen production capacity by 2030, which help deliver significant carbon savings through the use of hydrogen across the economy.

Q32a. Could some net zero compliant hydrogen production pathways be disadvantaged by the introduction of an emissions threshold set at 15-20gCO_2e/MJ LHV? Yes/no.
Q32b. If yes, please explain which methods are likely to be disadvantaged and why.

Summary of responses



The majority of respondents (74%) believe that some net zero compliant hydrogen production pathways may be disadvantaged by the introduction of an emissions threshold set at 15-20gCO_2e/MJ_{LHV}. Of those respondents who answered 'yes' to the question, 46% believed that electrolytic hydrogen production would be at a disadvantage, specifically grid-connected electrolysers. A quarter of respondents suggested that production methods utilising CCU/CCUS will be disadvantaged. Further detail can be found in the Q32(b) response themes table in Annex A.

Our response

Our analysis of the potential hydrogen project pipeline suggests a 20gCO_2e/MJ_{LHV} hydrogen threshold would support large scale deployment of both CCS-enabled hydrogen (with sufficiently high capture rates and efficiency) and electrolytic hydrogen (if using low carbon electricity for the majority of the time) in line with government's ambition of up to 10GW hydrogen production capacityby 2030. See Figure 1 below.

The types of hydrogen producers which are unlikely to be able to meet this threshold would include those CCS-enabled plants (autothermal or steam methane reformation) with lower capture rates and/or production efficiency, and electrolytic hydrogen producers seeking to only use grid electricity, or use grid electricity the majority of the time, as the grid mix will not be fully decarbonised. For electrolysers seeking to use some grid electricity, the proposed approach is set out above (questions 16-18). It is therefore our view that the types of hydrogen producers that could be disadvantaged by setting the threshold at this level would only be those hydrogen producers of lower efficiency or higher carbon inputs, which would not be consistent with our overall approach to growing a low carbon hydrogen economy.

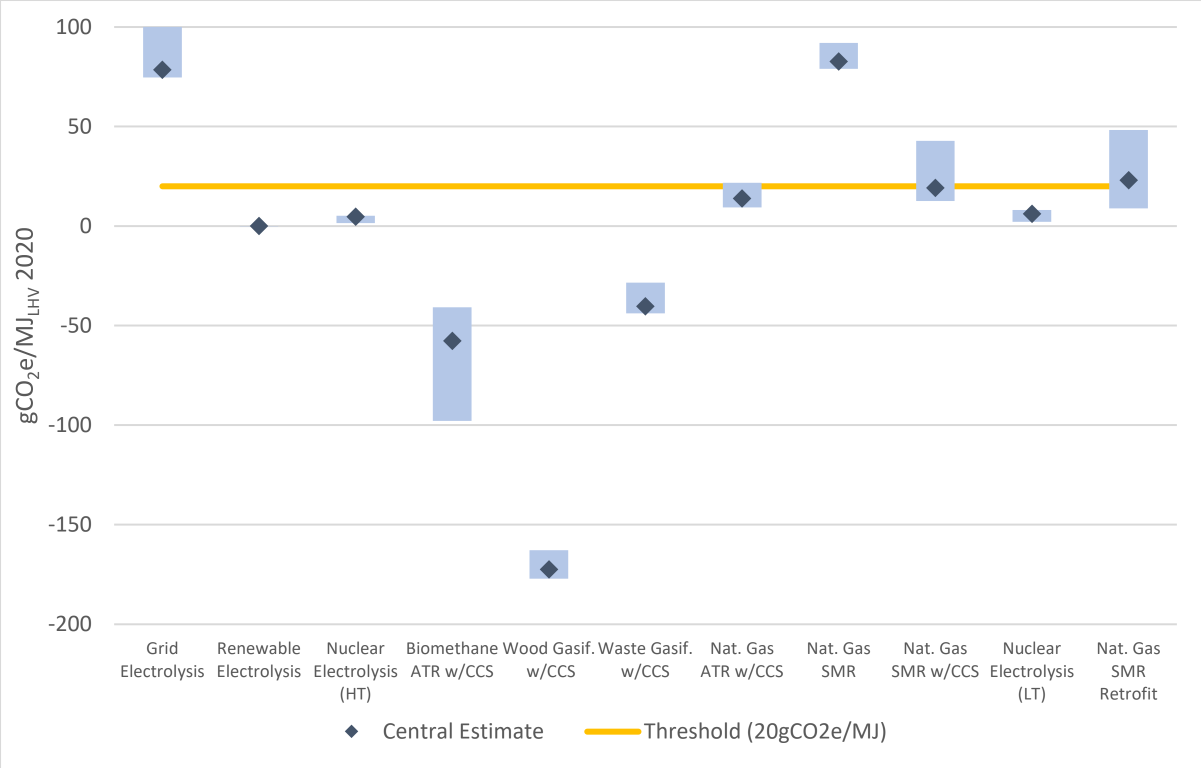


Figure 1: modelled emissions intensity of UK production pathways in 2020

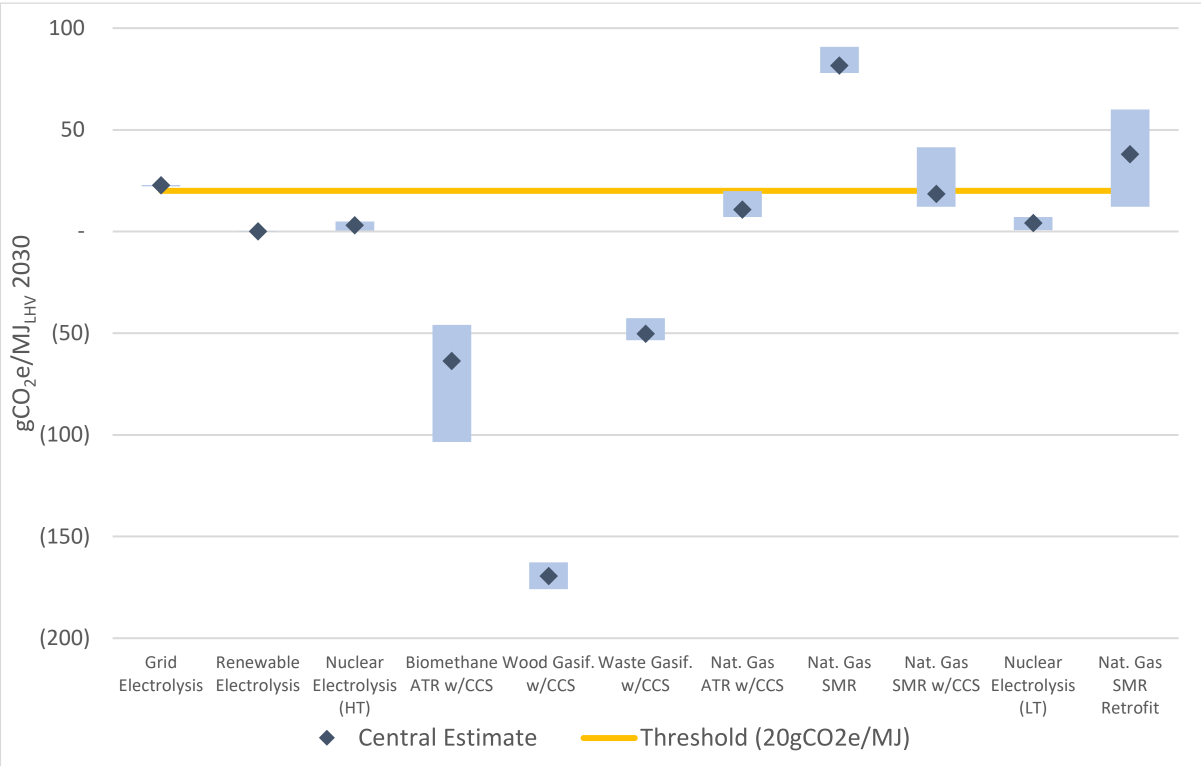


Figure 2: modelled emissions intensity of UK production pathways in 2030

Q33a. How could we ensure that a low threshold does not negatively impact projects on a trajectory to net zero and learning by doing at the early stages of hydrogen market development?
Q33b. What impact could this have on the UK achieving 5GW production capacity by 2030?[19]

Summary of responses

A range of views were gathered in response to these questions. The most common theme in the responses to question Q33a (shared by 35% of respondents) was that a higher initial threshold should be set that is decreased (tightened) over time as the industry develops, as a low initial threshold may hinder early hydrogen producers on the net zero trajectory. A lesser number of respondents suggested other options, such as setting different thresholds for different types of hydrogen producers, giving leeway if a low threshold is used and supporting the initially proposed low threshold.

Many respondents were also keen to highlight that specific production methods including both CCS-enabled and electrolytic hydrogen will be vital for reaching net zero and should not be limited by an overly strict threshold. More detail can be found in the Q33(a) response themes table in Annex A.

The most common response theme to questions Q33b, which 19% of respondents mentioned, was that a low threshold would prevent the UK reaching its 5GW ambition by 2030 and that to reach this ambition a higher more realistic initial threshold would be necessary. Some went further, suggesting that the UK would have to choose between producing truly net zero hydrogen or reaching 5GW by 2030. However, almost as many respondents (17%) were satisfied with the currently proposed low threshold and believe it would not significantly impact the ability to reach the 5GW ambition.

Many respondents used their responses to this question to add further detail to their response for Q33a, rather than answering the question posed. Further detail can be found in the Q33(b) response themes table in Annex A.

Our response

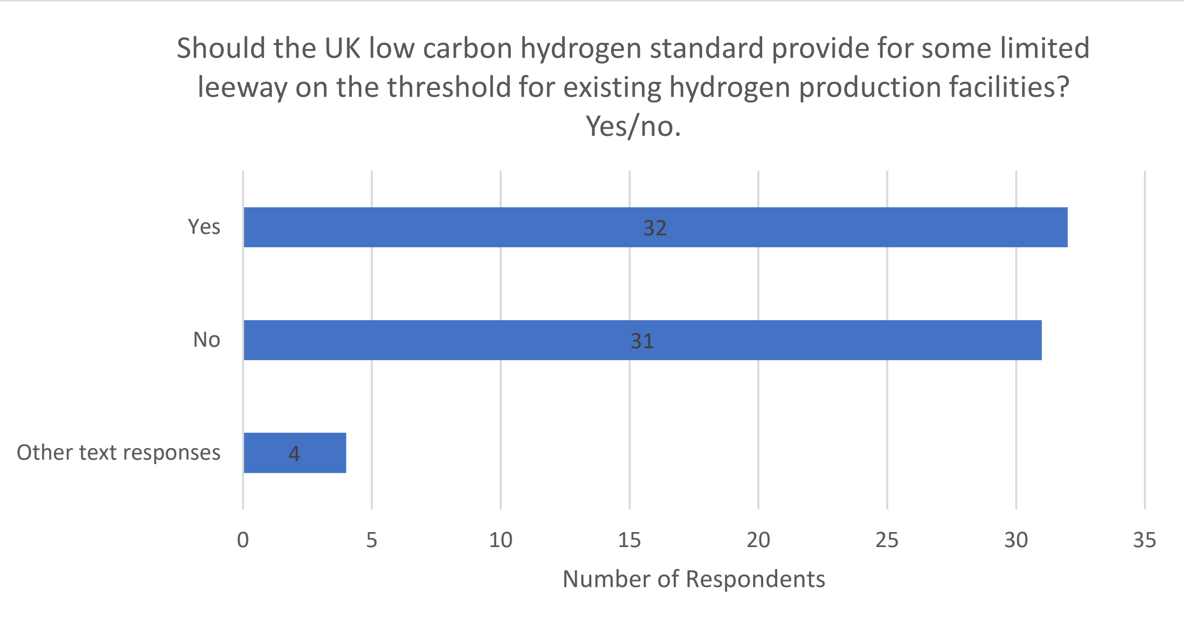
Analysis and market intelligence suggests that a $20gCO_2e/MJ_{LHV}$ threshold should be achievable for the majority of efficient electrolytic and CCS-enabled hydrogen producers planned in the UK, to support rapid growth of the hydrogen economy. The benefits of mass deployment at scale under a $20gCO_2e/MJ_{LHV}$ threshold are

[19] Since the consultation period closed the UK ambition has doubled to 10GW of low carbon hydrogen production capacity by 2030.

expected to outweigh the benefits of a stricter threshold, given this could restrict overall production levels and limit emissions savings associated with large scale deployment from the 2030s onwards.

Q34a. Should the UK low carbon hydrogen standard provide for some limited leeway on the threshold for existing hydrogen production facilities? Yes/no. Please explain the benefits to the approach you have suggested.
Q34b. If yes, is a 10% leeway suitable? Yes/no.

Summary of responses



There is no clear consensus over whether to allow a leeway for existing hydrogen production facilities, with a similar number of respondents both for and against such a provision.

There are a number of key themes which became evident after review of responses. Some respondents highlighted that a leeway could provide support to the development of the hydrogen market, whereas others suggested that a leeway would provide little value considering existing plants are currently producing high carbon hydrogen. These are summarised in the Q34(a) response themes table in Annex A.

On whether a 10% leeway is suitable, just over half of those responding to this question (16 out of 31) agreed.

Our response

In the consultation, the leeway was presented as a justifiable option where hydrogen supplied from existing ‘grey’ hydrogen production facilities continued to save significant emissions compared with the alternative means of supplying the same service, and those plants could provide a material contribution to UK hydrogen supply without preventing the introduction of newer, lower emission hydrogen pathways into the market. Government considers that steam methane reformation (SMR) plants retrofitted with carbon capture technology could play an important role in building the hydrogen economy, as their hydrogen will be attractive to off-takers who seek a low carbon supply. Some respondents highlighted that a leeway could provide support to the development of the hydrogen market, whereas opponents suggested that a leeway would provide little value considering existing plants are currently producing high carbon hydrogen. Not having a leeway would however be more consistent with the ambitious policy intent of the standard and its aim to treat all technologies equally.

It is our position that the standard will not provide a leeway on the threshold for existing hydrogen production plants. We consider this to be a fair and equitable approach, as it treats all technologies equally and is in line with our net zero ambitions. Evidence suggests that existing hydrogen plants could meet the threshold if they are retrofitted with carbon capture technology and have an adequate capture rate and efficiency.

Q35. What would be an appropriate level for a UK low carbon hydrogen standard if it were considering point of use emissions? Please set out your rationale for your answer.

Summary of responses

Only 10 respondents suggested a numerical value for a threshold set at point of use: five respondents stating a value between 5-10gCO_2e/MJ_{LHV} or less, two respondents stating a value between 15-24gCO_2e/MJ_{LHV}, and three respondents stating a value greater than 25gCO_2e/MJ_{LHV}. The largest group of respondents (31%) suggested that a point of use standard should not be within scope, with more suggesting a point of production standard instead. Further detail can be found in the Question 35 response themes table in Annex A.

Our response

As set out in the response to question 6, the standard will apply at ‘point of production’ rather than point of use. This is consistent with the views set out in question 35.

7.6. Delivery and administration

Q36. Which type of organisation would be best placed to deliver and administer a Low Carbon Hydrogen standard? Please include examples where possible of effective delivery routes for comparable schemes.

Summary of responses

The main observation drawn from these responses is that there is strong support for BEIS having a role in the delivery and administration of the standard. Of the 69 respondents, almost half answered “BEIS” or a collaboration between BEIS and other stakeholders, primarily industry and/or independent third-party accreditors.

The answers provided by the survey participants have been gathered into themes outlined in the Question 36 theme table in Annex A.

The most common theme amongst respondents (32%) was to recommend BEIS. The most common reasons stated were because BEIS would be independent, consistent, and best placed to deliver the scheme in line with other UK policies and goals such as meeting carbon budgets targets or our net zero commitments.

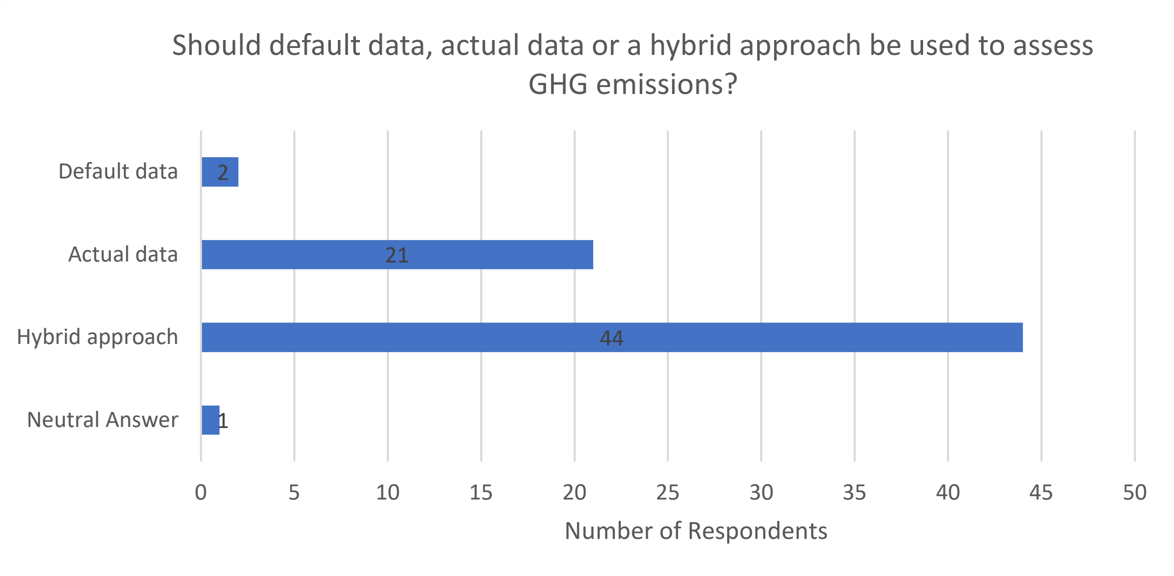
Our response

Whilst there is some merit in the option of having an industry led organisation to deliver and administer the standard, stakeholders have emphasised the need for oversight and engagement by BEIS to ensure that there is a suitable framework and transparency within which the standard is applied. In addition, it is important that there is strong alignment between the standard and the NZHF and HBM. There is significant value however in incorporating the experience of a range of stakeholders and regular consultation with industry. Therefore, a BEIS led collaborative approach, working with independent/third party organisations with experience of comparable schemes, would be the preferred way to implement the standard.

Compliance with the Low Carbon Hydrogen Standard will therefore initially be introduced as a requirement for hydrogen production applicants within the NZHF and HBM schemes. The practical application of the standard will help improve understanding of data collection and reporting processes, and what improvements could be made in assurance systems to feed into the longer-term administrative structure of a certification scheme.

Q37. Should default data, actual data or a hybrid approach be used to assess GHG emissions? Please explain the benefits to the approach you have suggested.

Summary of responses



There is strong support (65%) for a hybrid approach to the data used to assess GHG emissions. Of those answering "hybrid approach" or "actual data", 15% of respondents wanted there to be an incentive for or emphasis on collecting actual data and for data to only be used in situations where actual data was not available, or the emissions were below a set threshold.

65 respondents provided detail in support of their position. These answers have been gathered into themes outlined in the Question 37 response themes table in Annex A. The main reasons for preferring a hybrid model were that the hydrogen market is nascent, and hydrogen producers may find it difficult to have all the data available, and that flexibility is important. Many responses reported the importance for any default data provided to be conservative, to encourage hydrogen producers to move towards actual data wherever possible.

Our response

The standard will adopt a hybrid model and will provide default data for some of the pathways that have been modelled and are listed in the production pathways. This data will be conservative in most cases, providing an incentive to move to actual data as soon as possible. For applications to the NZHF and HBM projected data will also be accepted at the eligibility stages assuming there is sufficient evidence behind it.

It is important to have a true picture of the emissions related to hydrogen production and to observe any trends over the years. Actual data will be required to do this. The default data will be provided as an annex to the standard and will be updated regularly. Any actual data reported to check compliance with the standard will be reviewed periodically to ensure that the default data remains representative of the true market but sufficiently conservative to encourage the usage of actual data. Default data will remain representative for calculating GHG emissions at theoretical minimum pressure and purity as we understand these are theoretical calculations so actual data will not exist.

Q38. What should the options be for reporting and verification of low carbon hydrogen? Do any of the options outlined seem appropriate? Are any of these particularly problematic?
Q39. Are there any other options not listed here that are better suited for low carbon hydrogen reporting? Any thoughts on how possible trade-offs between accessibility and robustness or between accuracy and simplicity could be addressed?

Summary of responses

Most respondents (57%) are generally in support of reporting and verifying low carbon hydrogen production through a third-party or independent auditor rather than through self-reporting. A further 28% of respondents are also in support of a hybrid approach of self-reporting with verification through a third-party. Further detail can be found in the Question 39 response themes table in Annex A.

In the standard consultation, Question 39 was split into two separate questions. However, most respondents responded to Question 39 as a single answer, so all topics have been collated in a single theme table.

Of the 14 responses to the second part of this question, there were no prevailing suggestions of additional options that are better suited for low carbon hydrogen reporting. Four different themes on other options for reporting were suggested by more than one respondent: establishing distinction between elements in and out of hydrogen producers' control; prioritising third-party credibility in validation; using previously established emission reporting methods; reporting adaptability and the inclusion of a materiality threshold.

Due to the open-endedness of Question 39, many responses addressed certain wider attributes of the reporting method, including transparency, simplicity, accuracy and cost-effectiveness and third-party credibility in validation which is addressed in the previous response under Q38. Further detail can be found in the Question 39 response themes table in Annex A.

Our response

Self-reporting with annual third-party verification is viewed as the best combination for reporting and verification under the standard. This option provides a good balance between an adequate level of public confidence and any administrative burden and reflects accepted practice under other schemes.

Q40. What would be an appropriate frequency for verification or audit?

Summary of responses

A significant majority of respondents (77%) agree that verifications or audits should be performed annually. Some respondents offered more than one option for frequencies, stating that verifications or audits could be performed in different time frames.

There are other time frame recommendations for audits and verification that were made by the survey participants, which have been gathered into themes in the Question 40 response themes table in Annex A.

Our response

Compliance with the Low Carbon Hydrogen Standard will be introduced as a requirement within the NZHF and HBM. This will mitigate the risk of duplication and unnecessary administrative burdens being placed on producers. Details on verification, audit and assurance systems will be set out in the standard guidance, alongside application guidance and relevant contractual documents for the NZHF and HBM schemes.

Verification of reporting arrangements in the early phases of deployment may need inbuilt flexibility and alignment between the standard and other reporting requirements for the NZHF and HBM schemes. We will feed lessons learnt into the development of any administrative structure and verification / audit requirements of any relevant future funding or the development of the certification scheme.

Q41. Over what period of time should the standard be introduced?

Summary of responses

Of the 68 respondents, almost half (49%) want the standard to be introduced as soon as possible and a further 28% mentioned that they want the standard to be released in conjunction with the introduction of the HBM and/or the NZHF. Few respondents suggested time periods that were not relatively immediate, with 10% suggesting the standard is released by 2026, and only one respondent suggesting 2030. Further detail can be found in the Question 41 response themes table in Annex A.

Our response

In line with the consultation responses, the standard will be introduced ahead of application windows for NZHF and the 2022 HBM / NZHF electrolytic allocation round. In the first instance this will be used as eligibility and compliance criteria for hydrogen producers applying for support. The standard guidance will be published alongside this document. We will also be setting up a hydrogen certification scheme by 2025, to underpin deployment of low carbon hydrogen and support future international trade. We will engage further with industry on this in due course.

7.7. General

Q42. Do you have any other comments relating to the carbon standard proposals set out in this document?

Summary of responses

There were 52 responses to this question, which represents less than half of the total number of respondents. However, a third of these responses were null responses e.g., "nothing to add" or "no comment".

The substantive responses we did receive for question 42 were often comprehensive and diverse with a range of opinions shared. Some of the themes expressed by respondents included the need for ongoing communication as policy on hydrogen is developing, the interaction of the standard with the HBM, NZHF and wider government policy, the standard methodology and the government's twin-track approach.

Our response

- Engagement

During the consultation period, a number of public engagement events took place, and we intend to conduct further engagement as the government response and guidance document is published. We would welcome views from stakeholders on the government response and guidance document and may consider the feedback received for future reviews of the standard.

- Interaction of the standard with other schemes

Further comments by respondents on how the standard would interact with other policies and/or schemes, and in particular with the NZHF and HBM, are addressed throughout this response, or through the government responses to the consultations on the NZHF and HBM. Extensive engagement has been conducted across government to ensure best possible policy alignment.

- Standard methodology

Any outages in the CO_2 transportation and storage system will be taken into account in emissions calculations and at times when CO_2 is vented, it will be considered as not being captured. Upstream emissions from the natural gas' extraction, processing and transportation will also be accounted for. Further details on the methodology can be found in the standard guidance document. Producers will be expected to report their actual efficiency and capture rates, even in the events of plants ramping down their production capacity.

- Compliance

Monitoring and compliance frameworks will be set out in the corresponding guidance and / or contractual documents for the NZHF and HBM, alongside the standard guidance.

- Methane and CO_2 leakages

Further work is ongoing on methane leakage and potential CO_2 leakages at storage facilities. At present, carbon stored will be considered as being permanently stored. Work is also ongoing to understand the emissions impact of ammonia as a hydrogen carrier.

- CCUS-enabled hydrogen

The UK Hydrogen Strategy set out the government's 'twin-track' approach to supporting multiple production technologies including both electrolytic and CCUS-enabled hydrogen production. This will enable the rapid growth of the sector while bringing down costs. Both BEIS and Climate Change Committee analysis suggests that CCUS-enabled hydrogen will be needed, alongside electrolytic hydrogen, to deliver low carbon hydrogen at required scale and cost to achieve our 2030 ambition, as well as the expected step changes in demand for Carbon Budget 6[20] and net zero. Cost-effective CCUS-enabled production at scale in the 2020s can help drive investment in the wider value chain, building confidence in the sector.

[20] https://www.theccc.org.uk/publication/sixth-carbon-budget/

Annexes

Annex A – Data set

Question 1 response themes

	Theme	Responses (#)	Response (%)
1.1	Focus on UK pathways	64	74%
1.2	Alignment with International Standards	57	66%
1.3	Imported Low Carbon Hydrogen must be treated consistently	16	18%
1.4	UK should aim to be a Hydrogen 'Leader'	12	14%
1.5	Concerns about blue hydrogen imports/hydrogen for which emissions not being accounted	12	14%
1.6	Economic concerns about reliance on imports	6	7%

Despite the fact there were 96 responses in total, only 87 of these expanded on their yes/no answer, so the percentages in the table have been calculated using these 87 expanded responses. Where a respondent has noted two answers, both of these have been counted separately. It should also be noted that each theme is developed based on what was explicitly implied in the text of the responses, and themes were not detected in all of the responses.

Question 2 response themes

Q2 (Agree) response themes

	Theme	Responses (#)	Response (%)
2.1	Increased compliance	16	19%

2.2	Promotion of low carbon sources	12	14%
2.3	Increased buyer confidence	12	14%
2.4	Origin/Traceability of hydrogen	7	8%
2.5	Increased market growth within hydrogen economy	10	12%
2.6	Benefits in the future once hydrogen market has developed	11	13%
2.7	Beneficial if aligning with existing schemes and standards	7	8%

The percentages above have been calculated using the total number of text responses to this question, 87. Where a responder has noted multiple themes in their response, these have been counted separately.

Q2 (Disagree) response themes

	Theme	Responses (#)	Response (%)
2.8	Added complexity could delay market growth of hydrogen economy	7	8%
2.9	No requirement for one, should align to existing schemes	4	5%

The percentages above have been calculated using the total number of text responses to this question, 87. Where a responder has noted multiple themes in their response, these have been counted separately.

Question 3 response themes

Q3(a) response themes

	Theme	Responses (#)	Response (%)

3.1	International Consistency is important for future trade, imports and exports	58	62%
3.2	International Consistency is important but establishing the standard a priority	30	32%
3.3	Compatibility with emerging standards is important	40	43%
3.4	UK and International standards must align with net zero and decarbonisation targets	14	15%
3.5	UK standard should be more ambitious and lead the international standard	14	15%

The percentages above have been calculated using the total number of text responses to this question, 94. Where a responder has noted multiple separate themes in their response, both of these will have been counted separately.

Q3 (b) response themes

	Theme	Responses (#)	Response (%)
3.6	Increased potential for importing and exporting difficulties	30	37%
3.7	UK less desirable to trade with or invest in	34	41%
3.8	UK less desirable for operations due to operational complexity	20	24%
3.9	Concerns about low-quality Hydrogen imports	11	13%

The percentages above have been calculated using the total number of text responses to this question, 82. Where a responder has noted multiple separate themes in their response, both of these will have been counted separately.

Q3(c) response themes

	Theme	Responses (#)	Response (%)
3.10	Defined carbon intensity threshold	30	48%
3.11	Established GHG emissions calculation criteria and aligned system boundaries	30	48%
3.12	Lifecycle Analysis	11	18%
3.13	Consistent and aligned sustainability criteria	7	11%
3.14	Aligned purity standards	11	18%
3.15	Quality Assurance, Verification and Certification	3	5%
3.16	GWP factors	2	3%
3.17	Feedstock Origin	4	6%

The percentages above have been calculated using the total number of text responses to this question, 62. Where a responder has noted multiple separate themes in their response, these will have been counted separately.

Question 4 response themes

Q4(b) response themes

	Theme	Responses (#)	Response (%)
4.1	Green Hydrogen	48	69%
4.2	Biohydrogen	8	11%
4.3	Nuclear	5	7%
4.4	Blue Hydrogen	20	29%

4.5	Against CCS & CCUS	4	6%
4.6	Other methods	5	7%

The percentages above have been calculated using the total number of text responses to this question, 70. Where a responder has noted two separate themes in their response, both of these will have been counted separately.

Q4(c) Response Themes

	Theme	Responses (#)	Response (%)
4.7	Focus on end GHG emissions	17	44%
4.8	Technology neutral	10	26%

The percentages above have been calculated using the total number of responses to this question, 39. Where a responder has noted two separate themes in their response, both of these will have been counted separately.

Question 5 response themes

	Theme	Responses (#)	Response (%)
5.1	There must be a distinction between ‘Zero Carbon’ hydrogen renewables and other ‘Low Carbon' hydrogen pathways	23	32%
5.2	Multiple categories provide greater transparency and choice to consumers	16	22%
5.3	Encourages investment, innovation, and competition	8	11%
5.4	Multiple categories allow a premium market demand for the lowest hydrogen carbon emission pathways (e.g., green), incentivising up-stream businesses to invest in the technology	7	10%

The percentages above have been calculated using the total number of text responses to this question, 72. Where a responder has noted two separate themes in their response, both of these will have been counted separately.

Question 6 response themes

Q6(b) response themes

	Theme	Responses (#)	Response (%)
6.1	Point of use would be a reliable better representation of emissions within a product's lifecycle	15	32%
6.2	Point of use would provide greater accuracy and transparency for consumers/end-users	2	4%
6.3	Point of use would encourage production close to end users and facilitate the growth of local hydrogen ecosystems	2	4%
6.4	Levels the playing field within hydrogen and with other fuels	2	4%

The percentages above have been calculated using the total number of text responses to this question, 47. Where a responder has noted two separate themes in their response, both of these will have been counted separately.

Question 7 response themes

Q7(b) Response Themes

	Theme	Responses (#)	Response (%)
7.1	A book and claim custody system would be most appropriate because it permits some flexibility.	5	7%
7.2	A 'book and claim' system is likely to be easier, faster to implement and less costly.	11	16%

7.3	A mass balance approach is more reliable, traceable and transparent.	12	18%
7.4	A mass balance system would ensure alignment with existing schemes	3	4%

The percentages above have been calculated using the total number of text answer provided, 68.

Question 8 response themes

Q8 response themes (yes)

	Theme	Responses (#)	Response (%)
8.1	A book and claim system is already a good approach	3	6%
8.2	Other relevant comments	6	11%

The percentages above are taken from the total number of yes/no responses (53), with the yes responses further broken down here. The total number of text responses were 21.

Question 9 response themes

Q9(b) response themes

	Theme	Responses (#)	Response (%)
9.1	99.9 purity and 3MPa pressure (alignment with the CertifHy Standards)	8	12%
9.2	Purity of 97-98%	5	8%
9.3	It would be beneficial for the scheme to offer more than 1 option	3	5%

9.4	Different end users have different requirements in terms of purity and pressure.	7	11%

The percentages above have been calculated using the total number of text answers to this question, 65.

Q9(c) Response Themes

	Theme	Responses (#)	Response (%)
9.5	Defining a reference purity and pressure could disadvantage producers that do not require hydrogen at the reference level pressure and purity. Producers should not be forced to perform unnecessary (and energy intensive) processing in order to reach a standard.	6	16%
9.6	Over-specification in purity and pressure can be responsible for additional costs and emissions, especially for early hydrogen projects.	6	16%
9.7	It is important that purity and pressure levels are undertaken on an end-to-end basis	6	16%
9.8	The purity and pressure levels should be market-driven to ensure flexibility.	2	5%

The percentages above have been calculated using the total number of text responses to this question, 37.

Question 10 response themes

Q10(b) response themes

	Theme	Responses (#)	Response (%)
10.1	A greater standardisation of hydrogen will increase efficiency and may help facilitate future development standards	6	8%

10.2	Setting a minimum pressure and purity may limit the hydrogen use which can be utilised at a range of varying pressures	5	7%
10.3	Producers that produce lower-pressure hydrogen can be disadvantaged while high-purity hydrogen supply chains are incentivised	12	16%

The percentages above have been calculated using the total number of text responses to this question, 75.

Question 11 response themes

Q11(b) Response Themes

	Theme	Responses (#)	Response (%)
11.1	Addresses the issue of leakages or other issues at hydrogen production sites	5	11%
11.2	Provides a more accurate picture of the potential emission impacts of hydrogen	14	32%
11.3	Allows for transparency and accountability	7	16%
11.4	Important for fair comparison between other sources	3	7%

The percentages above have been calculated using the total number of text responses to this question, 44. Where a responder has noted two separate themes in their response, both of these will have been counted separately.

Question 12 response themes

Q12(b) response themes

	Theme	Responses (#)	Response (%)

12.1	Hydrogen's GWP is too uncertain and not clearly understood to include	13	28%
12.2	GWP is too complex and difficult to apply	8	17%
12.3	Complications arising from fugitive losses of hydrogen would impact the effectiveness of GWP's application	7	15%
12.4	No other national or international standards include GWP	7	15%

The percentages above have been calculated using the total number of text responses to this question, 47. Where a responder has noted two separate themes in their response, both of these will have been counted separately.

Question 13 response themes

Q13(b) response themes

	Theme	Responses (#)	Response (%)
13.1	5% is appropriate as is similar to other standards e.g., TÜV SÜD and CertifHy, and will support international consistency	18	27%
13.2	A materiality threshold will reduce the administrative and accounting burdens of reporting emissions	6	9%
13.3	Align the threshold with other GHG reporting under UK and international schemes	5	8%
13.4	Adopt a 1% threshold, provided 95% emissions are included - same basis as the Life Cycle Assessment (PAS2050) and will avoid producers gathering data at significant cost that doesn't boost confidence in the standard	5	8%

13.5	5% is too high if the aim to is to reduce GHG emissions of hydrogen over time to reach net zero	4	6%

The percentages above have been calculated using the total number of text responses to question 13b, 66. Where a responder has noted two separate themes in their response, both will have been counted separately.

Question 14 response themes

	Theme	Responses (#)	Response (%)
14.1	CCU could be included as an allowable benefit under the hydrogen standard, however further detailed work and appropriate legislation is required.	12	20%
14.2	More than 100 years is a minimum time for proven permanence.	5	8%

The percentages above have been calculated using the total number of text responses to this question, 61.

Question 16 response themes

Q16(a) response themes

	Theme	Responses (#)	Response (%)
16.1	Undertaking a flexible approach	14	16%
16.2	Grid-connected electrolysers	4	5%
16.3	Renewable or Zero-Carbon Energy Sources as the only acceptable form of low-carbon green hydrogen	15	17%
16.4	Utilising Power Purchase Agreement (PPA)	20	23%

16.5	Requesting Guarantees of Origin	16	18%
16.6	Threshold for source carbon intensity	28	32%
16.7	Temporal and geographical correlation.	4	5%

The percentages above have been calculated using the total number of responses to this question, 87. Where a responder has noted two separate themes in their response, both of these will have been counted separately.

Question 17 response themes

Appropriate accounting options response themes

	Theme	Responses (#)	Response (%)
17.1	All proposed options are appropriate	5	7%
17.2	Allow electrolysers to connect to the grid	31	44%
17.3	Allow physical links	15	21%
17.4	Traded activities - PPA for Renewably Sourced Hydrogen	22	31%
17.5	Temporal Correlation	17	24%
17.6	Additionality and integrating renewables for Hydrogen production	13	18%
17.7	Geographical Correlation	10	14%

The percentages above have been calculated using the total number of responses to this question, 71. Where a responder has noted two separate themes in their response, both of these will have been counted separately.

Problematic options response themes

	Theme	Responses (#)	Response (%)
17.8	Physical Links	10	33%
17.9	Temporal and Geographical Correlation	6	20%
17.10	Grid-connected Electrolysis	6	20%
17.11	Additionality Requirement	4	13%
17.12	Traded Activities Alone	5	17%
17.13	Requirements that are “too strict”	3	10%
17.14	Accounting methods are time-wasting	1	3%

Percentages above have been calculated using the total number of responses to this question, 30. Where a responder has noted two separate themes in their response, both of these will have been counted separately.

Question 18 response themes

	Theme	Responses (#)	Response (%)
18.1	Determining and reviewing the carbon intensity associated with the supply of electricity	19	30%
18.2	Utilising Power Purchasing Agreements	4	6%
18.3	Consideration of temporal and geographical correlation	6	9%
18.4	Understand whether the electricity is based on Traded Activities	2	3%

The percentages above have been calculated using the total number of responses to this question, 64. Where a responder has noted two separate themes in their response, both of these will have been counted separately.

Question 19 response themes

	Theme	Responses (#)	Response (%)
19.1	Measurement of carbon content	20	25%
19.2	New build requirement	15	19%
19.3	Regulation of power sector	20	25%
19.4	Consistency in approach of hydrogen production and other low carbon electricity uses	5	6%
19.5	Off-grid connections	11	14%
19.6	Associating renewable electricity with hydrogen production	8	10%

The percentages above have been calculated using the total number of responses to this question, 80. Percentages have been rounded to the nearest whole number.

Question 20 response themes

	Theme	Responses (#)	Response (%)
20.1	A requirement for additionality would artificially constrain the development of low carbon production adding further complexities, constrains and costs.	41	67%
20.2	Additionality requirement would help balance peaks and troughs in energy demand.	3	5%

20.3	Additionality requirement must be pragmatic in its approach.	6	10%
20.4	Standard should accept assurances that electricity used is renewable.	5	8%
20.5	Need to consider wider UK energy policy.	3	5%

The percentages above have been calculated using the total number of text responses to this question, 61. Percentages have been rounded to the nearest whole number.

Question 21 response themes

Q21(b) response themes

	Theme	Responses (#)	Response (%)
21.1	Additionality measures should be implemented because it would provide consistency and a level playing field.	14	24%
21.2	Additionality measures should not be implemented because it would add unnecessary constraints.	11	19%
21.3	It is important to pay attention to the embodied emissions of these technologies.	3	5%
21.4	No explicit opinion on additionality measures, but if they are implemented, they need to be consistent with existing standards.	2	3%
21.5	Who should be responsible for implementing additionality measures.	2	3%

The percentages above have been calculated using the total number of text responses to this question, 58. Percentages have been rounded to the nearest whole number.

Question 22 response themes

Q22(a) response themes

	Theme	Responses (#)	Response (%)
22.1	The introduction of counterfactuals should be aligned with the DfT's RTFO methodology.	8	15%
22.2	Counterfactuals should be introduced as they indicate the genuine GHG-savings.	5	10%
22.3	Counterfactuals will promote circular economy and support the values of the waste hierarchy.	9	17%
22.4	Counterfactuals would increase the potential feedstock supply for low carbon fuel production.	5	10%
22.5	Waste fossil feedstocks should not be considered with counterfactuals; waste fossil feedstocks are fossil fuels and should be treated as such.	2	4%
22.6	Counterfactuals are a complex method and difficult calculate	5	10%

The percentages above have been calculated using the total number of text responses to this question, 52. Where a responder has noted two separate themes in their response, both of these will have been counted separately.

Q22(b) response themes

	Theme	Responses (#)	Response (%)
22.7	Supporting fossil waste feedstocks in hydrogen production would lead to the increased production of low carbon hydrogen	3	8%

22.8	Supporting fossil waste feedstocks in hydrogen production would lead to an increase in carbon emissions and other harmful pollutants	8	21%
22.9	Supporting fossil waste feedstocks in hydrogen production would slow the phase-out of fossil fuels and introduction of renewables	2	5%

The percentages above have been calculated using the total number of text responses to this question, 38. Where a responder has noted two separate themes in their response, both of these will have been counted separately.

Question 23 response themes

Q23(a) response themes

	Theme	Responses (#)	Response (%)
23.1	Averaging Consignments	22	30%
23.2	Separate Consignments with averaging	17	23%
23.3	Separate Consignments	14	19%
23.4	Transparency in monitoring of inputs and evidence of emissions reductions needed.	6	8%
23.5	Dependent on producer/user specific needs	4	5%
23.6	Energy input for production must be 'green'	4	5%

The percentages above have been calculated using the total number of responses to this question, 74. Where a responder has noted two separate themes in their response, both of these will have been counted separately.

Q23(b) response themes

	Theme	Responses (#)	Response (%)

23.7	Simple and transparent	9	35%
23.8	Allows flexibility for products with varying inputs.	6	23%
23.9	Highest impact on promoting low carbon hydrogen	2	8%
23.10	Incentive to achieve better GHG savings	2	8%

The percentages above have been calculated using the total number of responses to this question, 26. Where a responder has noted two separate themes in their response, both of these will have been counted separately.

Question 24 response themes

Q24 response themes – units suggested

	Theme	Responses (#)	Response (%)
24.1	$gCO_2e/kg\ H_2$	7	9%
24.2	gCO_2e/MJ_{LHV}	56	74%
24.3	Other	2	3%
24.4	Combination of units	7	9%
24.5	No specific unit chosen	7	9%

The percentages above have been calculated using the total number of responses to this question, 76. Where a responder has noted multiple themes in their response, these have been counted separately.

Theme 24:1 sub-themes

	Sub-Theme	Responses (#)	Response (%)

24.1.1	Preferred metric in market	2	29%
24.1.2	Easier to compare for consumers	1	14%
24.1.3	Transparent and provides clarity	1	14%

The percentages above have been calculated using the total number of responses to this question, 7. Where a responder has noted multiple themes in their response, these have been counted separately.

Theme 24.2 sub-themes

	Sub-Theme	Responses (#)	Response (%)
24.2.1	Gives clarity and avoids complications	3	5%
24.2.2	Consistent with existing standards and policies	21	38%
24.2.3	Mindful of HHV unit used for natural gas	4	7%
24.2.4	Mindful of hydrogen source	1	2%
24.2.5	Standard conversion factor should be published alongside unit	2	4%
24.2.6	Must be reviewed to be consistent with net-zero pathways	1	2%

The percentages above have been calculated using the total number of responses to this question, 56. Where a responder has noted multiple themes in their response, these have been counted separately.

Theme 24.3 sub-themes

	Sub-Theme	Responses (#)	Response (%)
24.3.1	gCO_2e/kWh	1	1%
24.3.2	gCO_2e/gH_2	1	1%

Theme 24.4 sub-themes

	Sub-Theme	Responses (#)	Response (%)
24.4.1	Depends on type of hydrogen and end-use	2	29%
24.4.2	Both LHV and HHV	2	29%

The percentages above have been calculated using the total number of responses to this question, 7. Where a responder has noted multiple themes in their response, these have been counted separately.

Theme 24.5 sub-themes

	Sub-Theme	Responses (#)	Response (%)
24.5.1	Too complex for this consultation	1	14%
24.5.2	Consistent with existing standards and policies	5	71%
24.5.3	Depends on source of hydrogen	1	14%

The percentages above have been calculated using the total number of responses to this question, 7. Where a responder has noted multiple themes in their response, these have been counted separately.

Question 25 response themes

	Theme	Responses (#)	Response (%)
25.1	Market value	3	6%
25.2	Energy based	9	17%
25.3	Enthalpy based	3	6%
25.4	System expansion	6	12%
25.5	Mass allocation	1	2%
25.6	Economic value	1	2%
25.7	Hierarchy method	1	2%
25.8	Considered on a case-by-case basis	5	10%
25.9	Further consideration required	3	6%
25.10	Should be consistent with other certification schemes and/or international standards	4	8%

The percentages above have been calculated using the total number of responses to this question, 52. Where a responder has noted multiple themes in their response, these have been counted separately.

Question 27 response themes

Q27(b) response themes

	Theme	Responses (#)	Response (%)

27.1	Water	13	38%
27.2	Emissions to air and air quality	15	44%
27.3	Use of raw materials, natural resources and energy	3	9%
27.4	Sustainability	3	9%
27.5	Biomass sustainability (inc. land use and deforestation)	8	24%
27.6	Inclusion of positive non-GHG impacts	1	3%
27.7	Environmental impacts and damage	5	15%
27.8	Risk of future emission escape	1	3%
27.9	Aligned with existing criteria	2	6%
27.10	Waste disposal routes and by-products	3	9%
27.11	Food vs fuel issues	1	3%
27.12	Source of hydrogen	6	18%
27.13	Production location of hydrogen	3	9%
27.14	End-use of hydrogen	1	3%
27.15	Scale of deployment	2	6%
27.16	Local supply chains	1	3%

The percentages above have been calculated using the total number of text responses to this question, 34. Where a responder has noted multiple themes in their response, these have been counted separately.

Q27(c) response themes

	Theme	Responses (#)	Response (%)
27.17	Already managed through existing policies, environmental planning regulations or regulatory processes	24	59%
27.18	Will overcomplicate the standard and add complexity due to difficulties in quantifying	17	41%
27.19	May limit investment due to uncertainties	1	2%
27.20	GHG intensity is sufficient enough to prove sustainability	1	2%
27.21	Further research and considerations are required	4	10%

The percentages above have been calculated using the total number of responses to this question, 41. Where a responder has noted multiple themes in their response, these have been counted separately.

Question 28 response themes

	Theme	Responses (#)	Response (%)
28.1	Simple/ easier to deliver and understand	42	53%
28.2	Threshold is more appropriate for net zero target	8	10%
28.3	Hydrogen standards already employ the use of absolute emission value	4	5%
28.4	A comparator adds complexity and is less responsive to policy	7	9%

28.5	A percentage saving based on a fossil comparator is a credible alternative	5	6%
28.6	Either option is suitable	5	6%

The percentages above have been calculated using the total number of text responses to this question, 79. Where a responder has noted two separate themes in their response, both of these will have been counted separately.

Question 29 response themes

	Theme	Responses (#)	Response (%)
29.1	Simplicity enabling faster uptake to market and ease of regulation	27	34%
29.2	Consistency and harmonisation across the hydrogen economy	13	16%
29.3	Incentive for innovation and growth to produce cleaner Hydrogen	25	32%
29.4	Diversity of production technologies	7	9%
29.5	Clarity where grants and subsidies should be spent	9	11%
29.6	Differentiation between production technologies and their benefits and benchmarking	15	19%
29.7	Consumer and investor confidence on impacts of different production technologies	6	8%
29.8	Transparency	6	8%

The percentages above have been calculated using the total number of text responses to this question, 79. Where a responder has noted two separate themes in their response, both of these will have been counted separately.

Question 30 response themes

Q30(a) response themes

	Theme	Responses (#)	Response (%)
30.1	"Grandfathering" approach adoption	19	22%
30.2	Higher initial threshold will encourage first wave projects	16	18%
30.3	Grandfathering may lock-in high carbon developments	8	9%
30.4	A lower threshold is preferable to promote genuine low carbon technology	12	14%

The percentages above have been calculated using the total number of responses to this question, 88. Where a responder has noted two separate themes in their response, both of these will have been counted separately.

Q30(b) response themes

	Theme	Responses (#)	Response (%)
30.5	Investor confidence is boosted and developers/designers can plan into the future	23	37%
30.6	Too much uncertainty in the market at present to announce a trajectory	13	21%

The percentages above have been calculated using the total number of text responses to this question, 63. Where a responder has noted two separate themes in their response, both of these will have been counted separately.

Question 31 response themes

	Theme	Responses (#)	Response (%)

31.1	Thresholds consistent with net zero objectives	9	12%
31.2	Final thresholds consistent with <3-10 gCO_2e/MJ	13	17%
31.3	Thresholds consistent with 15-20 gCO_2e/MJ	33	43%
31.4	Thresholds consistent with 20-30 gCO_2e/MJ	10	13%
31.5	Thresholds consistent with >30 gCO_2e/MJ	8	10%
31.6	Multiple threshold approach	21	27%

The percentages above have been calculated using the total number of text responses to this question, 77. Where a responder has noted two separate themes in their response, both of these will have been counted separately.

Question 32 response themes

Q32(b) response themes

	Theme	Responses (#)	Response (%)
32.1	Respondent believes grid-connected electrolysis will be disadvantaged.	26	46%
32.2	Respondent believes methods utilising CCU/CCUS will be disadvantaged.	14	25%
32.3	Suggestion that the threshold should start higher and be reduced over time.	6	11%
32.4	Respondent believes SMR methods may be disadvantaged.	5	9%

The percentages above have been calculated using the total number of 'Yes' responses to this question, 56. Where a responder has noted two separate stages in their response, both of these will have been counted separately.

Question 33 response themes

Q33(a) response themes

	Themes	Responses (#)	Response (%)
33.1	An initially high threshold that decreases over time is preferable to a low threshold.	24	35%
33.2	An initial low threshold and/or that the initially proposed threshold will not negatively impact projects on a trajectory to net zero.	7	10%
33.3	If a low threshold is chosen, allowing for more leeway in the early stages of project development would benefit projects.	5	7%
33.4	There should be multiple thresholds, the threshold should be applied per project rather than per technology.	7	10%
33.5	The importance of electrolysis/electrolytic hydrogen and that a strict low threshold does not negatively affect these processes.	10	14%
33.6	The importance of blue hydrogen and that this technology should not be negatively impacted by an overly strict low threshold.	3	4%
33.7	Low carbon hydrogen projects are prioritised.	6	9%
33.8	Projects should not be limited to a single pathway.	3	4%

The percentages above have been calculated using the total number of text responses to this question, 69. Where a responder has noted two separate themes in their response, both will have been counted separately.

Q33(b) response themes

	Themes	Responses (#)	Response (%)

33.9	A low threshold will likely prevent the UK reaching the 5GW ambition announced in November 2021.	12	19%
33.10	There will not be an impact/ the current approach is acceptable.	11	17%
33.11	Importance of electrolytic hydrogen for ensuring 5GW target is met	8	13%
33.12	Market growth would be significantly slower without SMR projects, which would impact delivery of the 5GW target.	3	5%
33.13	The proposed low threshold will encourage net zero processes and pathways.	5	8%
33.14	A threshold which does not allow projects to come forward in the 2020s will put the 5GW production target at risk.	5	8%
33.15	The importance of blue Hydrogen to the UK's net zero strategy and that the proposed low threshold may hinder this key industry.	4	6%

The percentages above have been calculated using the total number of responses to this question, 63. Where a responder has noted two separate themes in their response, both will have been counted separately.

Question 34 response themes

Q34(a) response themes

	Theme	Responses (#)	Response (%)
34.1	There is no value in supporting higher carbon hydrogen projects through a leeway mechanism for existing projects	14	23%

34.2	Yes, but existing hydrogen producers must evidence plans to produce cleaner hydrogen over time	6	10%
34.3	Yes, a leeway would provide support to the development of the market	11	18%

The percentages above have been calculated using the total number of text responses to this question, 62. Where a responder has noted two separate themes in their response, both will have been counted separately

Question 35 response themes

	Theme	Responses (#)	Response (%)
35.1	Point of use standard should not be within scope/ not appropriate	19	31%
35.2	Point of production standard preferred	8	13%
35.3	Multiple thresholds	7	11%
35.4	Start with higher threshold and lower over time	5	8%
35.5	≤ 5-10gCO_2e/MJ_{LHV}	5	8%
35.6	Differing threshold for green and blue hydrogen	2	3%
35.7	≥25gCO_2e/MJ_{LHV}	3	5%

The percentages above have been calculated using the total number of text responses to this question, 62. Where a responder has noted two separate themes in their response, both of these will have been counted separately.

Question 36 response themes

	Theme	Responses (#)	Response (%)

36.1	BEIS	22	32%
36.2	BEIS/government body in collaboration with other stakeholders (i.e. industry, third-party accreditors)	12	17%
36.3	Independent/third party organisations with experience (e.g., BSI, REAL, Ofgem, Oil and Gas Association, Low Carbon Contracts Company)	20	29%
36.4	Industry-led (including support from BEIS or third-party auditor)	7	10%
36.5	Other types of organisations (Public sector body accountable to BEIS; institutional body)	4	6%
36.6	Existing schemes (e.g., RTFO, ISCC, RHI, ETS, TUV-SUD)	11	16%

The percentages above have been calculated using the total number of text responses to this question, 69. Where a responder has noted two separate themes in their response, both will have been counted separately

Question 37 response themes

	Theme	Responses (#)	Response (%)
	Hybrid approach		
37.1	Hybrid approach is in line with existing schemes	24	37%
37.2	Hybrid incorporating emissions thresholds	5	8%
37.3	Hybrid gives flexibility	7	11%
37.4	Hybrid – type of data is dependent on technology used / difficulty or cost of deriving actual data (e.g., due to maturity of technology)	22	34%

	Actual data		
37.5	Actual data – enables robust certification	8	12%
37.6	Onus on reporting actual data / provide incentives	11	17%

The percentages above have been calculated using the total number of responses to this question, 65. Where a responder has noted two or more separate themes in their response, each of these will have been counted separately.

Question 38 response themes

	Theme	Responses (#)	Responses (%)
38.1a	Prioritising third-party verification	33	57%
38.1b	Prioritising third-party verification with consignment reporting	13	22%
38.1c	Issues with third-party verification	4	7%
38.2a	Prioritising self-reporting	3	5%
38.2b	Issues with self-reporting	5	9%
38.3a	Prioritising hybrid reporting	16	28%
38.3b	Variable hybrid reporting over time	4	7%

The percentages above have been calculated using the total number of responses to this question, 58. Where a responder has noted two separate themes in their response, both of these will have been counted separately.

Question 39 response themes

	Theme	Responses (#)	Responses (%)

39.1	Distinction of elements in and out hydrogen producers' control	2	7%
39.2	Verifying third-party credibility	2	7%
39.3	Use of previously established emission reporting methods	2	7%
39.4	Report adaptability	2	7%
39.5	Inclusion of a materiality threshold	2	7%
39.6	Other prioritisations	6	21%

The percentages above have been calculated using the total number of text responses to this question, 29. Some respondents address multiple themes in their answer, such that the sum of responses here will exceed the number of responses that gave comments (14).

Question 40 response themes

	Theme	Responses (#)	Response (%)
40.1	Every 5 years	1	2%
40.2	Every 3 years	1	2%
40.3	Annually	47	77%
40.4	Every 9 months	1	2%
40.5	Bi-annually	5	8%
40.6	Quarterly	4	7%
40.7	Monthly	2	4%

40.8	Constant	1	2%
40.9	No fixed frequency	3	5%

The percentages above have been calculated using the total number of responses to this question, 61. Where a responder has noted two separate themes in their response, both of these will have been counted separately.

Question 41 response themes

	Theme	Responses (#)	Response (%)
41.1	As soon as possible	33	49%
41.2	Immediately	3	4%
41.3	By 2022	15	22%
41.4	Between 2023 - 2024	7	10%
41.5	By 2026	7	10%
41.6	In line with HBM introduction/NZHF	19	28%

The percentages above have been calculated using the total number of responses to this question, 68. Where a responder has noted two separate themes in their response, both of these will have been counted separately.

Question 42 response themes

	Theme	Responses (#)	Response (%)
42.1	Policy interactions	7	20%
42.1	Understanding of carbon intensity	7	20%
42.3	Business model	5	14%

42.4	Transparency and communication	4	11%

The percentages above have been calculated using the total number of responses to this question, 35. Where a responder has noted two separate themes in their response, both of these will have been counted separately.

Annex B – List of respondents

The following organisations responded to the government response. Nine personal responses were also received from individuals.

Adelan Ltd

Air Products PLC

Alderley plc

Aldersgate Group

AMP Clean Energy

AngloAmerican

Arup

Association for Decentralised Energy

B9 Energy Storage Ltd

Bellona

bp

BPP Technical Services Limited

British Standards Institute (BSI)

Brookfield

Cadent Gas Limited

Carlton Power/Trafford Green Hydrogen Ltd

Centrica Plc

Chartered Institution of Building Services Engineers (CIBSE)

Conrad Energy Limited

Cudd Bentley

Dalton Nuclear Institute, The University of Manchester

Decarbonise Gas Alliance

Drax Group plc

E3G

Electricite de France - EDF

Energy Networks Association

Energy UK

Eneus Energy Ltd

Eni

Equinor

Essar Oil

Field Consulting/Carbon Engineering

Gasunie

GFD

GHD Group Pty Ltd (GHD)

Green Alliance

H2 Evolution Ltd

H2 Green, a Getech Group company

HiiROC Limited

HV Systems

HyCymru, Wales Hydrogen Trade Association

Hydrogen UK

HyGen Energy Ltd

Ikigai Capital + Thames Estuary Growth Board

Inovyn (an INEOS Company)

IOGEN Corporation

Islandmagee Energy

ITM Power

Johnson Matthey

KBR Inc

Kelton Engineering Ltd

Kiwa Ltd

Lancashire Enterprise Partnership

London Energy Transformation Initiative (LETI)

Levidian

Marine Energy Wales

Microgeneration Certification Scheme Service Company Limited (MCS)

Mutual Energy

National Grid

National Nuclear Laboratory

Next Gen Renewables

Nuclear Industry Association

North West Hydrogen Alliance

Octopus Renewables & RES Green Hydrogen Partnership

Oil & Gas UK (OGUK)

Orsted

Peel NRE

Phillips 66 Ltd

Plagazi UK Ltd

Progressive Energy Limited

Qeng Ho Ltd.

The Association for Renewable Energy & Clean Technology (REA)

Regen

RenewableUK

RWE AG

Scottish Hydrogen and Fuel Cell Association

Scottish Power

Scottish Renewables

Shetland Islands Council

Siemens Energy

Sizewell C

SKUUNAQ Energy Ltd

Society of Motor Manufacturers and Traders (SMMT)

Scottish and Southern Electricity (SSE)

Stanlow Terminals Limited

Statera Energy

Statkraft

Storegga (Acorn Hydrogen)

Summit E&P

Sustainable Crediton

Swindon & Wiltshire Local Enterprise Partnership (SWLEP)

Technip Benelux B.V

Tees Valley Combined Authority

The Carbon Capture and Storage Association (CCSA)

The Institution of Engineering and Technology

Total Energies

Triton Power

TUV SUD National Engineering Laboratory

TWI Ltd

Tyseley Energy Park

UK Atomic Energy Authority (UKAEA)

UK Hydrogen and Fuel Cell Association

UK Petroleum Industry Association Ltd (UKPIA)

Uniper

University of Bath (Supergen Bioenergy Hub)

Valero Energy

Vysus UK Limited

Weald Action Group

Zenobe Energy Limited

Annex C – Statement responses

Some responses took the form of statements rather than responses to the questions provided. The questions have been analysed and considered as part of the consultation process.

Statements submitted for the public consultation vary widely in topic and address a number of aspects of the consultation and its associated documents. In general, respondents who submitted statements welcomed the public consultation process and showed a general approval for the initiative, its measures, and its strategic aim. Although statements were varied, some common themes were identified within the responses, including the need to differentiate standards between green and blue hydrogen, incentivising low-carbon production and discouraging fossil fuels, as well as technical aspects of units and methodologies of the proposed Standard.

	Topic	Responses (#)	Respons e (%)
S.1	Need for further differentiation of standards for low-carbon electrolytic (green) hydrogen and low-carbon fossil-fuel based (blue) hydrogen	3	19%
S.2	Incentivising low-carbon hydrogen production while discouraging fossil-fuel solutions.	2	13%
S.3	The need for further focus on developing supply chains and the advantages this poses	5	31%
S.4	Need to include and further explore other production methods on an equal footing	3	19%
S.5	Requirement for DEVEX and early CAPEX support	3	19%
S.6	Progressive adjusting and monitoring of low-carbon threshold	2	13%
S.7	The need of considering full life-cycle and embodied emissions of solutions	2	13%

S.8	The need to create supply chains and skills that can support the hydrogen economy	4	25%
S.9	Technical observations on proposed units and methodologies	4	25%

The percentages above have been calculated using the total number of responses as open statements. Where a responder has noted two separate themes in their response, both of these will have been counted separately.

Annex D – Consultation questions list summary

1. Do you agree that the standard should focus on UK production pathways and end uses whilst supporting future export/imports opportunities? Yes/no. Please expand on your response.

2. Would there be benefits in developing the standard into a certification scheme? Yes/no. Please provide detail.

3. a. Is international consistency important, or should the UK seek to develop a low carbon hydrogen standard primarily based on the UK context and criteria set out above? Please provide detail. 3. b. If elements of a UK standard differ to comparable international standards or definitions, would this impact the ability to facilitate investment in the UK or cause issues for business operations across borders? Yes/no/unclear at this stage. Please provide detail. 3. c. If answering yes to 3b, what elements of existing low carbon hydrogen standards or definitions are most important to ensure international consistency?

4. a. Should the standard specify a list of hydrogen production pathways, which would be updated periodically or on request? Yes/no. 4. b. If yes, we would welcome respondents' views on what production methods could have significant potential in the UK in the near term. 4. c. If no, we would welcome respondents' views on alternative options.

5. a. Do you agree that the standard should adopt one label of 'low carbon' hydrogen, or would it be valuable to have multiple categories? 5. b. If multiple categories, what benefits would we get from adopting this approach in terms of emissions reduction and consumer confidence?

6. a. Do you agree that a UK low carbon hydrogen standard should be set at the 'point of production'? Yes/no. b. If no, what would the advantages be of the standard making assessments at 'point of use' or 'point of use + in use emissions'?

7. Which chain of custody system would be most appropriate for a UK low carbon hydrogen standard: a mass balance or a book and claim system? Please explain the benefits of your chosen option. 8. Should other CoC options be considered instead? Yes/no. If yes, please provide detail.

9. a. If the system boundary was set at the point of production, should there be defined reference purity and pressure levels for a UK low carbon hydrogen standard? Yes/no. 9. b. If yes, what should they be? 9. c. If no, what are the benefits to not defining reference purity and pressure levels? 10. a. Should there be minimum pressure and purity requirements for hydrogen to meet the standard? Yes/no. 10. b. What could the potential implications of setting minimum purity and pressure requirements be?

11. a. Do you agree that embodied emissions should be omitted from the calculation of GHG emissions under a low carbon hydrogen standard, to ensure comparability with global and UK schemes? Yes/no. 11. b. If no, what are the benefits to including embodied emissions in the calculation of GHG emissions, and what should be done to ensure that hydrogen is on a level playing field to other energy vectors?

12. a. Do you agree that a UK low carbon hydrogen standard should include the global warming potential of hydrogen? Yes/no. 12. b. If no, are there other options for accounting for the GWP of hydrogen outside of a UK low carbon hydrogen standard that could support compatibility with existing standards/schemes?

13. a. Should a materiality threshold for total emissions be included in the life cycle assessments of hydrogen pathways? Yes/no. 13. b. If yes, what would the most appropriate level be and why?

14. a. Should CCU with proven displacement or permanence be included as an allowable benefit in GHG calculations under a UK low carbon hydrogen standard? Yes/no. 14. b. If yes, what should a suitable minimum time be for proven permanence and which applications should be eligible? 15. Should CCU credits only be allowed for biogenic carbon, and not allowed for fossil carbon sources? Yes/no.

16. As the grid is decarbonising rapidly, so will grid connected hydrogen production pathways. How should government policy take into consideration hydrogen production pathways using grid electricity as primary input energy now? Please explain the benefits to the approach you have suggested. 17. a. What options should we consider for accounting for the use of electricity under a UK low carbon hydrogen standard? Do the options outlined seem appropriate? Are any of these particularly problematic? Please explain your reasoning. 17. b. Of the options considered, should further conditions be included to mitigate any negative impacts or potential unintended consequences, such as driving additional high carbon power generation, and what could these conditions be? 18. What evidence should BEIS consider ahead of making decisions around the use of electricity as primary input energy for hydrogen production?

19. How should low carbon electricity use in hydrogen production be accounted for in order to support the deployment of hydrogen production via electrolysis, whilst avoiding unintended consequences such as increased generation from high carbon power sources (impacting grid decarbonisation)? 20. Should a UK low carbon hydrogen standard include a requirement on additionality and why? Please explain the benefits to the approach you have suggested.

21. Should additionality considerations also apply to renewable heat and other input energy vectors such as biomethane, in the same vein as for low carbon electricity and why? Yes/no. Please explain the benefits to the approach you have suggested.

22. a. Should waste fossil feedstocks be considered with counterfactuals under a UK low carbon hydrogen standard? Yes/no. Please explain the benefits to the approach you have suggested. 22. b. What are the potential implications of supporting the use of any particular waste streams in hydrogen production?

23. What is the most appropriate way to account for hydrogen produced from a facility that has mixed inputs (high and low carbon)? Please explain the benefits to the approach you have suggested.

24. What are the most appropriate units to calculate GHG emissions of low carbon hydrogen?

25. What allocation method should be adopted for by-product hydrogen and why?

26. Should the standard allow for negative emissions hydrogen to be reported? Yes/no.

27. a. Should non GHG impacts be taken into account? Yes/no. 27. b. If yes, what criteria or factors should be taken into account and how? 27. c. If no, please set out your rationale for your answer.

28. Given the many potential end uses of hydrogen, and the rapid expansion of low carbon supplies required, do you agree that an absolute emissions threshold be adopted, rather than a percentage saving based on a fossil comparator? Yes/no. Please provide detail. 29. Should the standard adopt a single threshold or several, and why?

30. a. Should the GHG emissions threshold be set at a higher level in the early stages of hydrogen deployment, with a trajectory to decrease over time? Yes/no. Please explain the benefits to the approach you have suggested. 30. b. If yes, should this decreasing trajectory be announced from the offset? Yes/no. Please explain the benefits to the approach you have suggested.

31. What would be an appropriate level for a point of production emissions threshold under a UK low carbon hydrogen standard? Please set out your rationale for your answer.

32. a. Could some net zero compliant hydrogen production pathways be disadvantaged by the introduction of an emissions threshold set at 15- 20gCO_2e/MJ_{LHV}? Yes/no. 32. b. If yes, please explain which methods are likely to be disadvantaged and why.

33. a. How could we ensure that a low threshold does not negatively impact projects on a trajectory to net zero and learning by doing at the early stages of hydrogen market development? 33. b. What impact could this have on the UK achieving 5GW production capacity by 2030?

34. a. Should the UK low carbon hydrogen standard provide for some limited leeway on the threshold for existing hydrogen production facilities? Yes/no. Please explain the benefits to the approach you have suggested. 34. b. If yes, is a 10% leeway suitable? Yes/no.

35. What would be an appropriate level for a UK low carbon hydrogen standard if it were considering point of use emissions? Please set out your rationale for your answer.

36. Which type of organisation would be best placed to deliver and administer a Low Carbon Hydrogen standard? Please include examples where possible of effective delivery routes for comparable schemes.

37. Should default data, actual data or a hybrid approach be used to assess GHG emissions? Please explain the benefits to the approach you have suggested.

38. What should the options be for reporting and verification of low carbon hydrogen? Do any of the options outlined seem appropriate? Are any of these particularly problematic? 39. Are any other options not listed here that are better suited for low carbon hydrogen reporting? Any

thoughts on how possible trade-offs between accessibility and robustness or between accuracy and simplicity could be addressed?

40. What would be an appropriate frequency for verification or audit?

41. Over what period of time should the standard be introduced? (Any comments).

42. Do you have any other comments relating to the carbon standard proposals set out in this document?

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