Department for Business, Energy and Industrial Strategy

Consultation on a UK Low Carbon Hydrogen Standard

Submission from CIBSE

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THE RESPONDENT

The Chartered Institution of Building Services Engineers (CIBSE)

The Chartered Institution of Building Services Engineers, CIBSE, is the professional engineering institution that exists to 'support the Science, Art and Practice of building services engineering, by providing our members and the public with first class information'

CIBSE members are engineers who design, install, operate, maintain and refurbish life safety and energy using systems installed in buildings. CIBSE members include specialists in fire safety systems and fire engineering. Others, who are belong to the Society of Façade Engineering, a Division of CIBSE, specialise in the design and installation of cladding systems.

CIBSE is unusual amongst built environment professional bodies because it embraces design professionals and also installers and manufacturers and those who operate and maintain engineering systems in buildings, with an interest throughout the life cycle of buildings.

CIBSE has over 20,000 members, with around 75% operating in the UK and many of the remainder in the Gulf, Hong Kong and Australasia. CIBSE is the sixth largest professional engineering Institution, and along with the Institution of Structural Engineers is the largest dedicated to engineering in the built environment. Our members have international experience and knowledge of life safety requirements in many other jurisdictions.

CIBSE publishes Guidance and Codes providing best practice advice and internationally recognised as authoritative. The CIBSE Knowledge Portal makes our Guidance available online to all CIBSE members, and is the leading systematic engineering resource for the building services sector. It is used regularly by our members to access the latest guidance material for the profession. Currently we have users in over 170 countries, demonstrating the world leading position of UK engineering expertise in this field.

CONSULTATION RESPONSE

Executive summary

Given the significant uncertainty around cost implications and technical feasibility of low-carbon hydrogen production, CIBSE currently have reservations about the suitability of hydrogen for building uses, compared to other applications which have few or no other options for decarbonisation. However, as the CCC scenarios expect a significant contribution from hydrogen to the wider economy, both in annual energy terms and for system balancing purposes, whether and how low-carbon hydrogen can be produced clearly needs attention.

The creation of a standard would be useful to determine the carbon impact of hydrogen production options, drive innovation by setting ambitious requirements, identify the best routes to produce it, and allow a robust and fair comparison with other options. We therefore welcome this consultation. It must however be noted that **a standard on its own is very unlikely to be sufficient to inform strategic decision making**. As many points in the consultation make clear, for example about renewable energy capacity required, the **decisions on hydrogen production have multiple implications, and must be considered as part of the whole system to avoid un-intended consequences, now and in the long-term**. What appears a better route now could lock us into higher-carbon solutions, and waste time and resources. Some routes are inherently riskier than others, or provide fewer additional functions than "simply" a low-carbon energy vector (as valuable as that is). Decisions on hydrogen should not include a comparison only between different hydrogen production routes, but also with other options including:

- Overall system use of resources, whether they are low-carbon or not: we must aim for efficient use of energy resources
- Supply side options, including other options for system balancing e.g. storage, international grid connections
- Demand side options, including maximising the opportunities from demand reduction and management at the user level. As pointed out in many consultations in the past few years, we stress that in the building sector the potential for demand reduction and management is significant, and not appropriately addressed in existing and proposed policy.

We agree with the **proposed metric** i.e. gCO2e/MJ LHV (Lower Heating Value). This makes sense from an engineering perspective when comparing hydrogen with other energy vectors, and has the other significant advantage of aligning with existing standards elsewhere in the world. However, other impacts should also be reported on and in some cases be subject to requirements, for example air quality emissions.

We understand and agree with the need for the standard to provide an assessment of **carbon impact at point of production**, to allow comparison between different production routes. However:

- these **production routes should not only be UK-focused**. The standard must be technology agnostic and offer comparison with other routes, for example hydrogen that would be produced by solar-rich countries and imported to the UK (this option is non-negligible since 13% of H2 in 2050 would be imported, in the government strategy). In addition to providing the UK with a wider assessment of its options, it would also open the standard to uses worldwide, showcasing UK Net Zero expertise.
- the standard must cover **carbon impact up to point of use**. This could be reported separately from the impact up to production, but it is essential in order for consumers not only to assess hydrogen from different sources, but also to assess hydrogen in their application against other options: many end uses (e.g. the building sector) will have other options and hydrogen may not be the most appropriate for them, or for the overall system when considering other uses which should be prioritised as they have few or no other decarbonisation options. In addition to carbon impact, the standard should then also provide data on impacts using relevant metrics to that use; for example, in the building

sector, carbon impacts should be reported "up to the building meter", and in addition, as government is currently minded to use primary energy as a metric in several building-related regulations, then the standard should allow reporting of the impact of hydrogen not only on a carbon basis, but also primary energy.

We agree that the standard should also set a **threshold for "low carbon" hydrogen**. This should be as ambitious as possible, to set a stable long-term direction and really drive investment and innovation. **We think the current proposed threshold (15-20gCO2/MJ H2 LHV) is not ambitious enough, and poses significant risks**:

- **Higher carbon emissions**: not setting a Net Zero compliant direction: our assessment is that it would, by far, exceed what is currently factored into the CCC's Balanced Pathway 2050 scenario;
- **A less attractive option to end users, and delays in the low carbon heat transition:** for users who have the choice, hydrogen which is not really low carbon may not be an attractive option, and therefore the standard would not meet the intent of creating a demand for hydrogen. In the building sector for example, users may then decide to use electric heating (with or without heat pump) as a lower carbon option, but that transition to low-carbon heating would have been delayed on the expectation of future low-carbon hydrogen, resulting in higher emissions in that period.

The proposed threshold appears to have been designed so that all but the highest-carbon routes would be able to meet it, rather than being designed to drive what hydrogen production needs to achieve to contribute to a net zero carbon UK. Our recommendation is that the carbon threshold should be set to be compliant with CCC net zero scenarios (e.g. Balanced Pathway); we expect this would mean significantly lower levels e.g. at least 3-4 times lower than the figure currently proposed.

We appreciate that a Net Zero compliant threshold may not be entirely feasible now; however, early stage flexibility to support R&D should not hide factors which will have to be addressed, such as the increase in renewable capacity required for low-carbon hydrogen from electrolysis. Our recommendation would then be for the following **approach to thresholds**:

- An intermediate threshold which is tightened over time towards the 2050-Net Zero compatible threshold. There would need to be a regular review mechanism to ensure this is set at the right level, to be ambitious enough and really drive innovation.
- A long-term Net Zero compliant threshold, in place from the offset, which would drive innovation by providing a stable and ambitious goal and which could be used in 2 ways:

    - Production routes that would achieve it, or be the closest to it, could be given preferential treatment. For example, this would apply to electrolysis plant with truly additional renewable generation capacity.
    - Production routes which, using a carbon factor for 2050 grid electricity (e.g. 2gCO2/kWh, in the CCC Balanced Pathway scenario) would NOT meet the long-

term threshold, would not meet the standard or at least would be given lower-priority for funding, since they would represent a risk of carbon lock-in unless significant improvements to their performance happened in the future.

Any reliance on **renewable electricity being used by hydrogen production routes** to calculate their carbon impact should be supported by clear evidence of additionality e.g. their own newly installed capacity, or PPAs. We appreciate this would result in capital investments; however, it is the reality of “green” hydrogen production: additional renewable capacity will be required; for example, the CCC 2050 Balanced Pathway scenario estimates that an additional 120TWh of renewable electricity production will be required for the purpose of hydrogen production (CCC 6th Carbon Budget, 2020). These costs must be understood and reflected in business models and the whole system appraisal of our options to achieve Net Zero carbon.

Finally, there is no mention in the consultation of **monitoring and checking actual performance of hydrogen production once it is operational**. It is not clear whether or at what point compliance with the standard, and associated funding, would be subject to actual monitored performance data. We understand the value of a standard which can be used at the design and investment stages, particularly in these early years of R&D. However, ultimately, full compliance with the standard, and associated funding, must be subject to verification of actual performance. This applies to all routes, but is particularly important for routes with a high level of uncertainty and risk, in particular the fossil fuel based routes which rely on effective storage and low leakage (of methane, carbon dioxide and other GHG gases) to deliver carbon benefits. We strongly recommend the introduction of proposals for monitoring and disclosure, and ultimately for compliance to be linked to actual performance.

Consultation questions

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.?

Yes. While the immediate application is UK production routes, the end goal should be a standard which can be used for hydrogen produced abroad; not only would this showcase UK expertise abroad, it would also meet a real need, since the government’s hydrogen strategy does rely on imports (13%): these routes and their carbon impacts must be assessed, and this must be done on a comparable basis with UK production routes.

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

Yes probably, to provide confidence to end users and support export opportunities.

Q3 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***

Both are important. International consistency is useful to support export opportunities (both of hydrogen, and of UK expertise), and provide a comparable basis for imported hydrogen with UK-produced hydrogen, as per our response to Q1. However, this should not undermine the 8 criteria set out for the standard.

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.

c. If answering yes to 3b, what elements of existing low carbon hydrogen standards or definitions are most important to ensure international consistency?

Q4. ***a. Should the standard specify a list of hydrogen production pathways, which would be updated periodically or on request?***

No. It should be applicable to all production pathways.

b. If yes, we would welcome respondents' views on what production methods could have significant potential in the UK in the near term.

c. If no, we would welcome respondents' views on alternative options.

We strongly caution against the use of default values, especially at such an early stage of R&D: default values could be very unrepresentative of some technologies, they may not encourage innovation, and they would prevent a real understanding of the impact of various modes of production, potentially going against the very purpose of the standard i.e. encouraging improvements and a fair assessment of production routes. From the onset, the standard must create a culture of understanding, monitoring, and disclosure of impacts.

Q5. ***a. Do you agree that the standard should adopt one label of 'low carbon' hydrogen, or would it be valuable to have multiple categories?***

Yes, we agree that the low-carbon criteria should be the focus of the standard; however, different routes will have different impacts on factors other than carbon, and at the system level. For example, "green" hydrogen could provide a system balancing function at times of excess renewable electricity. There is therefore at the very least the need to report on other indicators alongside the main carbon criteria, and there may be a use for additional labels.

b. If multiple categories, what benefits would we get from adopting this approach in terms of emissions reduction and consumer confidence?

See a)

Q6. ***a. Do you agree that a UK low carbon hydrogen standard should be set at the 'point of production'?***

No. We agree that, for the purpose of identifying suitable hydrogen production routes, a calculation at point of production is needed. However, the standard should also offer a methodology for calculation up to point of of use, which could be used and reported on separately, or together with PoP impact. This is essential if the true carbon impact of hydrogen use is to be understood; not providing this is likely to limit demand from end users, therefore not fulfilling one of the intents of the standard.

b. If no, what would the advantages be of the standard making assessments at 'point of use' or 'point of use + in use emissions'?

The advantages are:

- A real understanding of impact: the overall impact of hydrogen will be influenced not only by its production, but also its storage and distribution; furthermore, its relative benefits will depend on its use; it may offer carbon benefits in some applications, but not be preferable in others.
- End user confidence, and therefore stimulating demand: Consumers will need information when deciding between hydrogen production routes and whether hydrogen is the best option for their application, compared to other energy sources and vectors, particularly electricity.

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 CoC options be considered instead? Yes/no. If yes, please provide detail.

Q9. 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.

b. If yes, what should they be?

c. If no, what are the benefits to not defining reference purity and pressure levels?

Q10. a. Should there be minimum pressure and purity requirements for hydrogen to meet the standard? Yes/no.

b. What could the potential implications of setting minimum purity and pressure requirements be?

Q11. 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, we agree this is on balance reasonable within the context of the standard alone, as on balance:

- This would best support consumers by providing comparability with other energy vectors: embodied carbon impacts are not currently included within the carbon factor for electricity.
- Embodied carbon impacts could be complicated to calculate and allocate in some production routes, where hydrogen production is closely linked to a wider process. For example, in the case of “green” hydrogen: it is currently expected that the renewable energy plant (e.g. turbines) would be installed not solely for the production of hydrogen, but would be used for that purpose at times of excess renewable electricity supply. In that case, how would their embodied carbon impact be allocated to hydrogen production e.g. apportioned in line with the proportion of electricity produced which is then used for hydrogen production rather than used directly? Or apportioned to the additional plant (i.e. peak capacity) estimated to have been installed for hydrogen production, compared to an electricity-only route which would use other means of storage?

However, ultimately it is carbon emissions that have the impact, not how they are reported, so an assessment does need to be made of the embodied carbon impact of hydrogen production and how that compares with carbon budgets for the industrial and/or infrastructure sectors, and with the embodied carbon impact of other options. This is another reason why we recommend that additional renewable plant capacity be taken into account in electrolysis routes, so that overall impacts are understood (see Questions 16-20).

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?

Q12. ***a. Do you agree that a UK low carbon hydrogen standard should include the global warming potential of hydrogen? Yes/no.***

Yes. We acknowledge the downsides such as reducing comparability with some (but not all) existing standards, however again, what matters is real-life impact on the climate, and this needs to be understood. The additional significant benefit is that this will encourage reduction in fugitive losses, and therefore improvements in efficiency and reductions in emissions.

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?

Q13. ***a. Should a materiality threshold for total emissions be included in the life cycle assessments of hydrogen pathways? Yes/no.***

Yes, this seems reasonable at least in the first few years. The threshold should however be improved as the technology and supply chains develop; for example, the standard could start by setting a threshold of 5%, but indicate that the direction of travel is 1%, aligned with other standards such as PAS2050.

b. If yes, what would the most appropriate level be and why?

See a)

Q14. ***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.***

No. This seems complicated and open to loopholes, so on balance we think that at this stage CCU shouldn't be given credit, until there are commonly accepted standards for how this should be done

b. 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.***

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.***

In policy terms, the standard can only go so far, and policy must apply an analysis across the whole system of various options, not only between hydrogen production routes but also with other options. It is essential that decisions on hydrogen should not include a comparison only between different hydrogen production routes, but also with other options including:

- Overall system use of resources, whether they are low-carbon or not: we must aim for efficient use of energy resources
- Supply side options, including other options for system balancing e.g. storage, international grid connections
- Demand side options, including maximising the opportunities from demand reduction at management at the user level. As pointed out in many consultations in the past few years, we stress that in the building sector the potential for demand reduction and management is significant, and not appropriately addressed in existing and proposed policy.

As references on this in applications to the building sector, and the importance to consider a range of options within the whole system, we recommend the work of CREDS (which is UKRI funded, with BEIS on the advisory board), for example the 2020 paper "*Building* *decarbonisation transition pathways*"[1], and the London Energy Transformation Initiative (LETI) 2021 paper "*Hydrogen: a decarbonisation route for heat in buildings?*"[2].

Through the standard, government policy has two ways to consider this: the carbon calculation methodology, and the requirements and carbon threshold to qualify as "low carbon" and, in turn be eligible for government support. The methodology should be agnostic and represent the true impact of hydrogen, to allow comparisons between production sources and between energy vectors. Therefore, if grid electricity is used, then the methodology should account for the carbon content of that grid electricity as current at the time, to reflect real impacts – with the caveat that options demonstrating robust additionality could be accepted, as per Q17

In parallel, in addition to calculating actual carbon impact using actual grid electricity factors, it should be straightforward for hydrogen producers to calculate what the carbon impact would be in the same production route, but using an electricity carbon factor for the future grid or for renewable electricity; this in turn could potentially be considered in funding applications – again, this is more a question of thresholds and funding criteria, than a question about the standard calculation methodology. – see details in Q30 on thresholds.

In turn, the calculated carbon impact will determine whether or not the resulting hydrogen meets the low-carbon threshold(s); to deal with the next few years where grid electricity is not fully decarbonised, a lower interim threshold could potentially be set, but the standard calculation and threshold should encourage a real understanding of the implications of hydrogen production, including its impact on required renewable energy capacity – see details in Q30 on thresholds and Q20 on renewable energy capacity.

Q17. ***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.***

As per our response to Q16, we think the methodology must reflect the real impact of hydrogen production, and it is low-carbon thresholds and funding criteria, not the fundamental principles of the methodology, which may be adapted over time in order to drive innovation while recognising R&D and transition periods. Claiming zero or low carbon electricity must be associated with robust evidence, such as physical links and PPAs.

In principle at this stage, we caution against the use of temporal factors; this is not consistent with how electricity is treated in other applications such as buildings, where a single carbon factor is used or, as anticipated in the upcoming updates to Building Regulations Approved Document L, a monthly carbon factor. Methodologies must be consistent across energy vectors and applications, to allow comparability and serve the needs of end users.

[1] https://www.creds.ac.uk/publications/building-decarbonisation-transition-pathways/
[2] https://www.leti.london/hydrogen

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?

As per a).

Q18. ***What evidence should BEIS consider ahead of making decisions around the use of electricity as primary input energy for hydrogen production?***

These questions and the very real risk of unintended consequences highlight the fact that the standard on its own is unlikely to be sufficient for strategic decision making, as it is necessarily limited in scope while for such decisions the whole system needs to be considered; funding decisions should not be based on carbon emissions from a particular production route on their own, since clearly any route will have an impact on the system, now and in the long-term. For example, while electrolysis routes do have requirements for additional renewable generation capacity, they also offer system balancing benefits, while the "blue" hydrogen route inherently has inherent risks and uncertainties, relying as it is on carbon capture and low fossil fuel leakage rates during production and transmission. In addition, decisions will also need to include comparison with other routes than hydrogen, as per Q16.

Finally, we cannot stress too highly the importance of **monitoring of actual impacts**: while we understand the need for funding decisions at the investment, design and construction stages to support R&D, there must be monitoring and reporting of actual impacts, and ultimately this must feed back into funding and policy decisions. This applies to all routes, but is especially true for routes which rely on fossil fuels and whose carbon benefits are therefore inherently risky. For example, the 2021 paper "*How green is blue hydrogen?*"[3] demonstrates how crucial it will be for "blue" hydrogen production to deliver low leakage rates not only of the carbon stored, but of methane throughout the distribution and production process. We are aware from a consultation event that BEIS think the conclusions in this paper would not apply in a UK context, because practices would be of higher standard; this may well be possible, but that precisely relies on a standard which is ambitious in the carbon threshold it sets (see our comments on this in Q31) AND which **delivers on this ambition in real life**, hence the importance of monitoring and reporting, with independent verification (see Q38).

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)?***

As per questions 16-18: The fact that hydrogen production by electrolysis will drive more demand for electricity, and that it could divert low-carbon electricity from other users unless it is accompanied by additional renewable capacity, is a reality. The methodology must reflect this, with robust criteria for any claims to using low-carbon electricity (e.g. actual plant with physical links, PPAs) even if it represents additional costs. The standard otherwise risks

[3] Howarth and Jacobson, 2021 https://onlinelibrary.wiley.com/doi/full/10.1002/ese3.956

encouraging certain routes without understanding their real technical and financial implications. Notwithstanding this, we understand the constraints of R&D, and are also very mindful that discouraging electrolysis in the short-term could “lock us” into “blue” hydrogen routes, with associated dependence on fossil fuel and inherent risks and uncertainties on carbon storage and leakage rates during transmission, production and storage. We think this can be addressed through a careful approach to thresholds, including a transition period – see Q30. We also strongly recommend the incorporation of requirements to monitor real impact, in order to provide robust appraisals and put all routes on a fair footing - see Q18 and Q37.

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.***

Yes, it is essential. We note the statement in the consultation that “*There is a risk that including such a requirement would increase costs around hydrogen production*”. This is the reality: whether hydrogen produced from electrolysis is low carbon does depend on the carbon content of the electricity being used, which itself in the future will be influenced by hydrogen production as a significant amount of renewable capacity may be required for hydrogen production alone. For example, the CCC 2050 Balanced Pathway scenario estimates that an additional 120TWh of renewable electricity production will be required for the purpose of hydrogen production (CCC 6^{th} Carbon Budget, 2020). As noted in Q16-19, this needs to be accounted for in the standard, alongside the likely need for policies. As noted in Q19 however, we understand the constraints of R&D, and are also very mindful that discouraging electrolysis compared to fossil fuel-based routes. We think this can be addressed through a careful approach to thresholds, including a transition period – see Q30, and by incorporating monitoring requirements of real impact, as recommended in Q18 and Q37.

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.***

Yes. We cannot see a reason why other sources would be treated differently; there is already a market and a need for green heat, as there is for green electricity, so the need to ensure additionality if this is used in hydrogen production is the same.

Q22. ***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.***

b. What are the potential implications of supporting the use of any particular waste streams in hydrogen production?

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.***

Averaging is probably the most straightforward, and most likely to drive improvements across the whole production.

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

We agree with the use of gCO2/MJ LHV, for consistency with existing standards.

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

The allocation should be done on LHV basis:

- This will be consistent with the unit used in other cases, providing simplicity and comparability
- It avoids under-allocating GHG impacts to hydrogen. We do NOT agree that other approaches would “over-allocate emissions to hydrogen”: the allocation must reflect the fact that hydrogen production will be the primary goal of the process, while other products are genuinely ancillary by-products, not co-products. As an aside: if this results in by-products being attributed very low emissions, this may actually help develop their market value and improve the financial viability of the overall hydrogen production process, as an ancillary benefit.

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

No. They could potentially be reported as informative, but not accounted for. The 2 strong arguments for this are:

- As stated in the consultation, an unintended consequence could be to reward inefficiencies.
- At the system level, there would be a real risk of double accounting savings; for example, the carbon stored in biomass or biofuels from agricultural or forestry sectors may already be “claimed” by these sectors.

This is another example of why a single criteria approach cannot deal with the complexity of hydrogen production, which requires a whole system approach and consideration of other factors, as mentioned in Q16.

Q27. a. Should non GHG impacts be taken into account?

Yes. There are multiple possible unintended consequences and non-carbon impacts must be evaluated, to ensure hydrogen production does not jeopardise other objectives. Reporting and essential requirements on key impacts should be part of the standard; for example, NOx emissions should be subject to at least the same requirements as other industrial and energy generation plant, taking account of long-term air quality objectives and the latest WHO guidelines. Again, we recommend impacts are evaluated at the system level not only between hydrogen production routes, but also including other options including alternative low-carbon energy vectors (e.g. renewables, nuclear) and one scenario maximising energy use reduction in all sectors.

b. If yes, what criteria or factors should be taken into account and how?

Essential environmental objectives, including air quality. As a minimum this should include all criteria which energy generation plant is currently subject to as part of environmental impact assessments, emissions restrictions etc.

c. If no, please set out your rationale for your answer.

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.

Yes, the threshold must be in absolute terms. It is the simplest and most stable means of comparison, both within the UK and when comparing with non-UK routes. Furthermore, savings compared to a fossil comparator are not representative of the reality of the alternatives, especially electricity, which are rapidly decarbonising.

Q29. Should the standard adopt a single threshold or several, and why?

On balance, we think there would be value in a combination of two thresholds: a transition threshold which, while being ambitious, would be designed to support R&D, and another threshold defining the long-term net zero-compliant goal – see details in Q30.

In any case, the same threshold must apply to all routes, to really identify and incentivise the lowest carbon forms.

Q30. 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.

Probably, since production processes are still not at maturity and their impact relies on that from grid electricity, which itself is still decarbonising; however, earlier flexibility should not hide factors which will have to be taken into account, such as the increase in renewable capacity required for low-carbon hydrogen from electrolysis. Our recommendation would be for the following combination of thresholds:

- An intermediate threshold which is tightened over time towards the 2050-Net Zero compatible threshold. There would need to be a regular review mechanism to ensure this is set at the right level, to be ambitious enough and really drive innovation.
- A long-term Net Zero compliant threshold, which would drive innovation by providing a stable and ambitious goal – see Q31 for our recommendations on what this goal should be; we do not think the current proposed threshold of 15-20gCO2/MJ H2 is ambitious

enough, and our analysis is that it is not consistent with the CCC budgets. This net-zero compliant threshold could be used in 2 ways:

- Production routes that would achieve it, or be the closest to it, could be given preferential treatment. For example, this would apply to electrolysis plant with truly additional renewable generation capacity.
- Production routes which, using a carbon factor for 2050 grid electricity (e.g. 2gCO2/kWh, in the CCC Balanced Pathway scenario) would NOT meet the long-term threshold, would not meet the standard or at least would be given lower-priority for funding, since they would represent a risk of carbon lock-in unless significant improvements to their performance happened in the future.

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

Yes, the end goal should be announced from the offset to provide a stable investment and R&D framework and an ambitious incentive for improvements; the details of the trajectory, i.e. the intermediate steps, would benefit from regular review in case they could be tightened faster.

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.

As explained in Q30, we think there should be one long-term threshold, and one transition threshold gradually tightened towards that long-term goal. We are therefore commenting here on the main, net zero compliant threshold.

Our analysis is that the proposed threshold of 15-20gCO2//MJ (LHV) is far from ambitious enough, and that it would cause two significant problems:

- **A less attractive option to end users, and delays in the low carbon heat transition:** Even the lower end, at 15gCO2/MJ i.e. 54 gCO2/kWh, would compare very unfavourably with grid electricity, whose current carbon factor is 198 gCO2/kWh (as stated in the consultation), and is expected to reach nearly zero status in 2035 (2gCO2/kWh by 2050, under the CCC Balanced Pathway scenario). This means that users which have a choice are likely to select other energy vectors, therefore not creating the demand which the standard seeks to achieve, and not delivering the expected benefits in terms of carbon emissions and demand management at the system level. In the building sector, homes would still have the option of heat pump heating, but they would have lost years or decades when their low-carbon heating transition could have happened, with additional emissions in that period. Similarly, gas-fed district heating schemes may still have the option to decarbonise by switching to heat pumps, possibly using low-grade / waste heat sources, but they may have lost decades in the hope of a transition from natural gas to low-carbon hydrogen.
- **Higher carbon emissions**: Where hydrogen at this carbon threshold is used, we believe it would result in emissions which are not compatible with a Net Zero scenario.

> For example, the CCC Balanced Pathway assumes 225 TWh of hydrogen production by 2050; at a carbon threshold of 15gCO2/MJ, this would represent a total of 12.15MTon, much higher than is allowed in the Balanced Pathways where the very large majority of remaining emissions are from agriculture and land use alone.

The proposed threshold appears to have been designed so that all but the highest-carbon routes would be able to meet it, rather than being designed to drive what hydrogen production needs to achieve to contribute to a net zero carbon UK.

Our recommendation is that the carbon threshold should be set to be compliant with CCC net zero scenarios; we expect this would mean significantly lower levels e.g. at least 3-4 times lower.

Q32.a. Could some net zero compliant hydrogen production pathways be disadvantaged by the introduction of an emissions threshold set at 15- 20gCO2e/MJLHV? Yes/no.

As indicated in Q31, we do not think that a threshold of 15-20gCO2e/MJ LHV is net zero compliant. We recommend a tighter, much more ambitious long-term threshold, possibly with intermediate threshold for the early R&D period, as detailed in Q30.

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?

See our response to Q30, with a long-term goal and gradually tightened thresholds. In addition, “learning by doing” must include actual performance, not just standard calculations at the investment and design stages; there must be monitoring and reporting of actual performance, and this must be available to independent scrutiny – see also Q18.

b. What impact could this have on the UK achieving 5GW production capacity by 2030?

As per Q30, an intermediate threshold could be designed to support R&D in the initial stage. However, we stress that the thresholds should not be selected on the basis that they would allow a government commitment to be met, but instead they must be designed to support the right long-term outcomes; it would be a very detrimental outcome if a carbon intensive route was encouraged because it meets a 2030 target, but results in lock-ins and vast sums of money invested, diverted from routes with lower-carbon potential but at earlier stages of development. Funding criteria and thresholds must support the right long-term goal of determining whether low-carbon hydrogen can be produced, and if so what are the best routes to do this.

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.

No. The standard must as much as possible set a comparable basis for various production routes. Furthermore, by comparison with the support needed for production routes at much earlier stages of development, it does not seem fair that such existing plant should benefit from leeway; in order to be deemed compliant and eligible for funding they should be encouraged to improve in order to meet the standard, or at the very least its carbon threshold if not all the other additional requirements.

b. If yes, is a 10% leeway suitable? Yes/no.

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.***

See our response to Q30: the threshold at point of use should follow the same principles, but with an additional allowance for efficiencies of distribution and storage up to point of use, comparable to that of other energy sources and vectors.

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.

We recommend this should be administered by an independent accreditation body, ideally with a steering group to review implementation and development on a regular basis; the steering group should include a wide variety of stakeholders, representing not only policy-makers and the hydrogen production industry, but also end users from various sectors. It is really important that end users are involved in this arrangement.

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.

As explained in Q4, we discourage the use of default values except in very limited cases (e.g. the 5% materiality threshold, as per Q13). Reliance on default data would be counter to innovation and improvement and would prevent robust decision making on such an important topic. In addition, as per Q18, we stress the need from the onset to create a culture of monitoring, understanding and disclosure of impacts: there must be plans for the standard to evolve and incorporate actual performance data, monitored in use, not just data from design stage assessments.

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?

Given the high levels of uncertainty at this stage, and the risks of under-performance of some hydrogen production routes (e.g. carbon and methane leakage during distribution, production, capture or storage), we strongly advise against self-reporting. The potential important role of hydrogen production, and the vast sums of money involved, justify at the very least third-party verification, and ideally third-party verification + consignment reporting.

Q39. 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?

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

At the very least, annual, but it may also be useful to determine, for each production routes, additional “gateway” points where verification is carried out.

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

As soon as possible, to inform as much R&D and funding as possible. The consultation intention to finalise design elements of the standard by early 2022 seems appropriate.

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

See executive summary

END

Please do not hesitate to contact us for more information on this response.