Green Hydrogen Standard 2.0 - Frequently asked questions

8 March 2024

Green hydrogen — hydrogen produced through the electrolysis of water with renewable energy — is a proven technology with huge potential to meet our energy security and climate change goals. The first edition of the Green Hydrogen Standard was launched in May 2022[1]. A revised Green Hydrogen Standard 2.0 (hereafter "GHS 2.0") was launched in December 2023 at COP 28[2]. In this note, we highlight some of the key features of GHS 2.0 and address some frequently asked questions.

1. Why do we need a global Green Hydrogen Standard?

Agreed standards and definitions are critically important for the rapid acceptance and use of green hydrogen[3]. Currently, there is no accepted definition of green hydrogen (sometimes called "renewable hydrogen"). National strategies and policies differ widely on the definition of renewable energy, the boundaries of the emissions accounting system, the emission thresholds at which hydrogen should be considered green, the production technologies, and the sustainability criteria that should apply. This lack of clarity and standardization is undermining efforts to accelerate the use of green hydrogen. Crucially, the distinction between green hydrogen and fossil fuel-based hydrogen (usually with much higher greenhouse gas emissions) is often purposefully blurred under the purposefully vague label of "clean hydrogen" or "low carbon hydrogen". GH2 argues that only genuinely clean hydrogen can help solve the climate crisis[4]. A global standard for green hydrogen supports policy and project development, lowers costs for producers and consumers, and helps build support and confidence in the market for green hydrogen and green hydrogen derivatives.

2. Why has the Green Hydrogen Standard been revised?

GH2 is committed to championing global best practice and revising its approach to standards and certification as the green hydrogen industry develops. While the number of announced green hydrogen projects is rapidly expanding, annual production of green hydrogen and green hydrogen derivatives on a commercial scale is limited[5]. Currently, green hydrogen accounts for <.1% global hydrogen production. The certification of green hydrogen production is almost exclusively limited to small scale demonstration projects. The Green Hydrogen Standard has been revised based on lessons learned from testing early-stage, large scale projects against the first version of the Standard[6] and feedback received from stakeholders. Proposed revisions to the Standard are reviewed by the Green Hydrogen Standard Committee (see below).

3. What has changed in GHS 2.0?

There are five major changes:

[1] https://gh2.org/article/industry-leaders-welcome-launch-global-green-hydrogen-standard
[2] https://gh2.org/article/updated-green-hydrogen-standard-welcomed-industry-leaders-cop28-includes-green-methanol-and
[3] IEA (2023a), Towards hydrogen definitions based on their emissions intensity, IEA, Paris https://www.iea.org/reports/towards-hydrogen-definitions-based-on-their-emissions-intensity.
[4] Malcolm Turnbull (2023) "Only genuinely clean hydrogen can help solve the climate crisis". *The Guardian*. 17 August 2023. https://www.theguardian.com/commentisfree/2023/aug/17/only-genuinely-clean-hydrogen-can-help-solve-the-climate-crisis
[5] The IEA (2023b) reports that "Global hydrogen production reached almost 95 Mt in 2022", while noting that "Production from water electrolysis continued to be relatively small, still below 100 kt H2 in 2022, which represents 35% growth compared to the previous year". IEA (2023b), Global Hydrogen Review 2023, IEA, Paris https://www.iea.org/reports/global-hydrogen-review-2023, License: CC BY 4.0
[6] https://gh2.org/article/dnv-appointed-support-gh2-green-hydrogen-standard-implementation

1. GHS 2.0 retains a <1kg CO2e / kg H2 "well-to-gate" greenhouse gas emissions threshold but will move toward a full life cycle assessment.
2. New requirements address the use of biomass in renewable electricity production and in the production of green hydrogen derivatives.
3. GHS 2.0 has been extended to cover Green Methanol and Synthetic Methane, including "well-to-gate" emission thresholds and a definition of eligible carbon sources.
4. New requirements address hydrogen emissions to address health and safety and hydrogen's indirect impact on climate change.
5. The Standard includes a "prequalification" offer for early-stage green hydrogen projects.

The rationale for these changes is explained below.

The GHS Committee will continue to review lessons learned and consider additional refinements.

4. How does the GHS 2.0 define Green Hydrogen?

The definition and threshold have not changed. Green hydrogen is defined as: "hydrogen produced through the electrolysis of water with 100% or near 100% renewable energy with close to zero greenhouse gas emissions" (the Standard). The Standard refers to "near 100% renewable energy", because it allows for some back-up in exceptional circumstances, so long as the maximum emissions threshold is not exceeded.

5. How does the GHS 2.0 define Renewable Energy?

The GHS 1.0 definition of renewable energy was based on the technologies that are the leading candidates for scaling up green hydrogen production: hydropower, wind, solar, geothermal, tide, wave and other ocean energy sources. GHS 2.0 now allows for the of biomass in renewable electricity production and in the production of green hydrogen derivatives, subject to strict safeguards.

The use of biomass for energy purposes accounts for over 10% of the global energy use. However, there are concerns that feedstock production causes direct and indirect land-use change, i.e., where the increased demand for feedstock leads to agricultural expansion and the conversion of natural lands[7]. Where biomass and/or biomass waste is utilized for the production of renewable electricity and/or the production of green hydrogen derivatives (such as green methanol and synthetic methane) GH2 accreditation and certification requires the project operator to demonstrate that there is a low risk of indirect land use change, including verifying that production of feedstock does not take place on land with high biodiversity, that land with a high amount of carbon has not been converted for feedstock production. Furthermore, the use of biomass and biomass waste must be comprehensively addressed and incorporated into the assessment of social and environmental impacts.

GH2 notes that some countries have determined that there is a role for nuclear energy to accelerate the shift from more polluting activities, such as coal generation. However, nuclear power raises some specific environmental and safety related issues which this Standard is not designed to address. GH2 welcomes if the Green Hydrogen Standard inspires further rules and standards also for nuclear and other forms of energy production with close to zero emissions.

[7] The land use change is "indirect" in the sense that it occurs outside the boundary of the biomaterial feedstock production operations and is driven by the increased demand for biomaterial and food feedstock. See IISD (2019) *Biofuels and Indirect Land-Use Change* https://www.iisd.org/ssi/wpcontent/uploads/2019/09/Biofuels_publications-1.pdf

6. What other sustainability aspects are covered in the Green Hydrogen Standard?

The Standard requires that the environmental, social and governance consequences of green hydrogen production are addressed and requires that the development opportunities and impacts of green hydrogen production and use are considered. Key questions include:

- Are the social and environmental impacts of new projects fully considered?
- Does the project comply with international human rights standards and are human rights promoted where the energy is produced?
- Has a good faith effort to engage key stakeholders and communities actively been made?
- Have key stakeholders and communities been provided with the information and potential opportunities to engage that they see as most relevant and needed?

These issues are vital considerations for investors, customers, consumers and the communities that host green hydrogen projects. The Standard seeks to maximise alignment with international best practice, including the IFC's Environmental and Social Performance Standards[8] , the Hydropower Sustainability Council's Hydropower Sustainability Standard [9] and the UN Sustainable Development Goals (SDGs).

7. What GHG emissions are included?

The Standard builds on a wide accepted methodology developed by the International Partnership for Hydrogen and Fuel Cells in the Economy (IPHE) with some refinements. It includes "scope 1" emissions from production, including water treatment and desalination, and "scope 2" emissions from on-site or purchased renewable electricity. It is expected that project operators calculate and report on the emissions associated with the delivery of hydrogen and its derivatives. The standard also encourages project operators to calculate and report on the embodied emissions associated with green hydrogen production. Subject to further refinement and testing, benchmarks addressing these emissions will be reflected in future versions of the Standard.

8. Why "close to zero" greenhouse gas emissions rather than zero?

GH2 is committed to the full life cycle analysis (LCA) of greenhouse gas emissions associated with green hydrogen production and utilisation, including embedded emissions. Our emissions thresholds are currently based on a "well to gate" methodology in line with the International Partnership for Hydrogen and Fuel Cells in the Economy (IPHE 2023).

In this context, green hydrogen is sometimes characterised as having zero greenhouse gas emissions. However, the production of renewable electricity can involve some greenhouse gas emissions. For example, there may be some greenhouse gas emissions associated with electrolysis and associated processes (such as water treatment/desalination), the use of grid electricity and backup systems. Accordingly, GH2 refers to "close to zero greenhouse gas emissions".

The Standard requires that projects operate at <=1 kg CO2e per kg H2 (taken as an average over a 12-month period) on a "well to gate" basis. The <=1 kg CO2e per kg H2 threshold is considerably lower

[8] IFC (2021) Performance Standards.
https://www.ifc.org/wps/wcm/connect/Topics_Ext_Content/IFC_External_Corporate_Site/Sustainability-At-IFC/Policies-Standards/Performance-Standards
[9] Hydropower Sustainability Council (2021) Hydropower Sustainability Standard
https://static1.squarespace.com/static/5c1978d3ee1759dc44fbd8ba/t/61379550f76c7d53f2b0f446/1631032662564/Hydropower+sustainabiity+standard+310821+01b.pdf

than the thresholds proposed by other so-called "clean hydrogen" or "low carbon hydrogen" standards, which have significantly higher emissions threshold to accommodate hydrogen production based on fossil fuels.

The GH2 Board will continue to review the performance of GH2 accredited projects on an annual basis, with the expectation that the boundaries of the emissions assessment framework can be widened, and that the emissions thresholds will be lowered in accordance with emerging best practice.

9. Are hydrogen emissions addressed?

Yes. There is a growing appreciation that any leakage of hydrogen will affect atmospheric composition (with implications for air quality) and have an indirect warming effect on climate, partially offsetting some of the climate benefits of the reduction in carbon dioxide[10]. Hydrogen is a small, leak-prone molecule that can indirectly warm the climate. Several studies have identified value chain components that may intentionally and/or unintentionally emit hydrogen. However, the amount of hydrogen emitted from infrastructure is unknown as emissions have not yet been empirically quantified. Recent research notes that present and future value chain emission rate estimates vary widely (0.2% to 20%): "the largest ranges in estimated emissions rates are associated with liquefaction (0.15% to 10%), liquid hydrogen transporting and handling (2% to 20%), and liquid hydrogen refuelling (2% to 15%)"[11].

Accreditation and certification under GHS 2.0 requires that the project operator: (i) has evaluated the risks associated with hydrogen emissions associated with the project; (2) has developed a plan to minimize hydrogen emissions; and (3) has established a system to monitor and measure hydrogen emissions. GH2 will review accredited projects on an annual basis and will establish a maximum threshold for hydrogen emissions within the boundaries of the emissions assessment framework in accordance with emerging best practice.

10. How does the Standard interact with national standards?

The Green Hydrogen Standard is a global minimum standard, aimed at providing national governments with a global reference point in further developing national and regional standards with a clear benchmark for green hydrogen. GH2 is working with national governments to encourage alignment with international best practice, including the Standard's definition of green hydrogen. The Standard acknowledges that the development of natural resources and energy markets is in the domain of sovereign governments to be exercised in the interest of their citizens and national development. To avoid duplication, demonstrating adherence to credible and comprehensive national requirements shall be deemed sufficient to meet GH2's accreditation and certification requirements.

11. How will green hydrogen be certified?

In response to the demand from project developers, GH2 has developed a "prequalification" offer for early-stage green hydrogen projects which we propose is integrated into the Standard. This enables project developers to demonstrate to investors, off-takers, government agencies and other stakeholders that projects will deliver green hydrogen (or its derivatives) produced with near-zero

[10] BIES (2022) "Atmospheric implications of increased hydrogen use" https://www.gov.uk/government/publications/atmospheric-implications-of-increased-hydrogen-use

[11] Esquivel-Elizondo, S., Mejia, A. H., Sun, T., Shrestha, E., Hamburg, S., & Ocko, I. (2023). Wide range in estimates of hydrogen emissions from infrastructure. https://doi.org/10.31219/osf.io/unzrm

emissions and with world-class sustainable development impact. Projects that are on track to meet the Green Hydrogen Standard will be designated by GH2 as "Pre-qualified in accordance with the Green Hydrogen Standard™" and will then have an opportunity to undergo full certification once the project/s enter the production phase.

Producers seeking GH2 accreditation should undertake the necessary preparatory work to demonstrate their project's adherence to the Green Hydrogen Standard. Project operators engage an Independent Assurance Provider accredited by GH2 to review the project. The Independent Assurance Provider consults the project operator and other stakeholders and prepares an assessment. A draft report is made available for public comment. The final report from the Independent Assurance Provider is then submitted to GH2's Accreditation Body. Projects that meet the Standard and have agreements and/or licenses with GH2 will be certified to use the label "GH2 Green Hydrogen" (under license) and will be eligible to obtain and trade GH2 certificates of origin for green hydrogen and derivatives such as green ammonia.

12. How does the Standard relate to "additionality"?

"Additionality" refers to the notion that grid-connected green hydrogen production should have a guaranteed additional source of renewable energy capacity. The concern is that the additional demand from green hydrogen production will reduce renewable energy consumption in other sectors with a negative impact on overall emissions.

Some governments, particularly the member states of the EU, have regulations that require green hydrogen producers to demonstrate that they are building new ("additional") renewable electricity capacity and/or limiting to production to periods of curtailment (when renewable electricity supply exceeds demand). There is a risk that such requirements are discriminatory and will stifle the development of the green hydrogen industry. Wider issues need to be addressed, including the subsidies that support fossil fuel-based energy and the regulatory bottlenecks that are delaying and increasing the cost of new renewable energy capacity. Moreover, additionality is not a concern in some markets, which already have high share of renewable electricity and/or where renewable electricity is the least cost option for adding generation capacity.

The GHS 2.0 allows project developers to "count electricity taken from the grid as fully renewable if they have concluded one or more power purchase agreements (PPAs)" subject to a number of conditions. PPAs should make use of credible[12] Energy Attribute Certificates (EACs), Renewable Energy Certificates or other guarantee of origin certification schemes (or similar proofs) where available. The Standard requires the project operator to undertake an evaluation of the project's utilisation of electricity and the impact on the energy market including, where applicable, network congestion and the impact of their operations on the greenhouse gas emissions from the electricity grid. The evaluation should consider technically feasible and cost-effective measures. Where the hosting government has established an additionality requirement, this must be respected.

13. Who is involved in developing the Standard?

[12] In accordance with the GHS General Principles the credibility and comprehensiveness of national requirements will be considered as part of the independent appraisal process, including broad based consultation with project stakeholders". In evaluating the credibility of national requirements, project operators and the Independent Assurance Provider should consider alignment with global best practice, such as the I-REC International Attribute Tracking Standard.

GH2 emphasizes the importance of multi-stakeholder dialogue. All stakeholders have important and relevant contributions to make. Governments, industry, consumers, public and private financial institutions, international and non-governmental organisations all have a role to play.[13]

The GHS Committee advises the GH2 Board on the implementation and elaboration of the Green Hydrogen Standard. The Committee meets virtually on a quarterly basis, and includes diverse representation from GH2 supporters, partner organisations and stakeholders. Additional details and draft terms of reference are publicly available[14].

In Q1 2023 the Committee GHS formed six working groups:

- WG 1 – Measuring GHG emissions from transportation, storage and distribution.
- WG 2 – Green Methanol.
- WG 3 – Green / Renewable/Synthetic Methane.
- WG 4 – Data standards for renewable electricity certification, including additionality, time matching, bidding zones.
- WG 5 – Fugitive hydrogen emissions.
- WG 6 - Guidance on water resource management.

Based on the WG deliberations, the GHS Committee made recommendations to the GH2 Board, which were adopted in November 2023.

14. Will the Standard evolve?

Yes. The Standard seeks to balance predictability and flexibility in a new and rapidly growing industry. Project proponents have emphasised the need for clear and stable standards to inform long term planning. Stakeholders are also in agreement that GH2 should take into account emerging best practices, particularly as projects are scaled up from pilots to large scale operation. GH2 will review the lessons learned from the accreditation and certification process in consultation with all stakeholders. Any subsequent refinements or modifications to the Standard will include transitional arrangements that will allow project operators to make the necessary adjustments within a reasonable timeframe before coming into force.

15. How can stakeholders support this work?

GH2 invites companies, governments and other stakeholders to become members. GH2 members are invited to participate in all GH2 initiatives, including its advisory and working groups. Members also join the Green Hydrogen Global Assembly, an annual meeting of senior business leaders, government officials, investment professionals, and civil society leaders to consider and agree strategies to accelerate this growth.

For more information on the Standard, contact Sam Bartlett, Director for the Green Hydrogen Standard and CEO Roundtable at sam.bartlett@gh2.org

About GH2

[13] https://gh2.org/about/our-principles
[14] https://greenhydrogenstandard.org/about/GHS-committee

The mission of the Green Hydrogen Organisation (GH2) is to dramatically accelerate the production and utilisation of green hydrogen across a range of sectors globally. It will push to rapidly decarbonise industries like steel, cement, fertilisers, shipping and aviation that have so far made limited progress reducing their emissions. In addition to its office in Geneva it is present in London, Perth, and Sydney.