Green Hydrogen Contracting Guidance

Achieving sustainable development with green hydrogen

Key considerations

- The green hydrogen economy can and should advance the UN Sustainable Development Goals (SDGs). The green hydrogen economy should in particular contribute to the meeting of SDGs on urgent action to combat climate change, ensuring access to energy, sustainable water management, inclusive growth and employment, and sustainable infrastructure and industrialisation.

- Making sure that the green hydrogen economy lives up to its potential to contribute to the SDGs will require innovative models and collaboration between developers, developments partners and the government from the early stages of the design of large projects.

- Governments and project developers could consider at the feasibility stage how green hydrogen projects can realistically and sustainably offer local employment opportunities, decarbonise grids and supply excess renewable energy or clean water to surrounding communities.

- This guidance addresses how SDGs can be furthered by green hydrogen projects, and considers the role of private capital, development finance institutions and bilateral development support to achieve SDGs. It also summarises developments and the unique potential for such efforts for green hydrogen projects in developing countries.

This brief is part of a set of guidance from the initiative on Green Hydrogen Contracting – for People and Planet. The project supports governments, communities, and companies in developing contracting practices for green hydrogen projects that ensure rapid expansion to everyone's benefit. The guidance has been developed by a working group consisting of governments, law firms, companies, and civil society groups to draw lessons learned from emerging practices in the green hydrogen industry. For further information, visit gh2.org/green-hydrogen-contracting or contact the GH2 Secretariat (ines.marques@gh2.org).

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1. Introduction

The green hydrogen economy can and must advance the UN Sustainable Development Goals (SDGs), given that they contribute to decarbonizing otherwise hard- to- abate sectors and can improve local access to new sources of clean electricity, fresh water, ammonia-based fertilizer; green employment and industrial development opportunities.

There are high expectations that the green hydrogen industry will generate new, green jobs. A study undertaken by McKinsey for the Africa Green Hydrogen Alliance (AGHA) found that the green hydrogen industry can generate up to 400,000 jobs by 2030 and 4.2 million jobs by 2050 in the six member countries of the Alliance.[1]

There are opportunities for green hydrogen projects to contribute to renewable energy and clean water by considering at the feasibility stage how projects can realistically and sustainably decarbonise and help stabilize local grids or supply excess renewable energy or desalinated water to surrounding communities.

There are however risks that the potential may not be realised, and that the industry ends up with characteristics historically similar to the extractive industries, with negative social and environmental consequences and possible social resistance to future projects.

[1] Kenya, Mauritania, Morocco, Namibia, and South Africa. Africa's Green Hydrogen Potential (2022), https://gh2.org/sites/default/files/2022-11/Africa%27s%20Green%20Hydrogen%20Potential.pdf

The promise of green hydrogen projects to help achieve the SDGs will only be met if the projects are well planned, appropriately executed, and operated in a way that is transparent to all stakeholders. It is also critical that policies and projects are designed in ways that avoid the result of developing countries merely exporting green hydrogen and its derivatives with no local benefit, and instead ensure that they create real value along the full supply chain. The Green Hydrogen Standard's definition of green hydrogen aims to contribute to such project design by requiring that producers conform to the highest standards on emissions, ESG performance and the sustainable development goals.[2]

This guidance addresses how the green hydrogen economy can contribute to several specific SDGs, focusing on specific SDGs that could be particularly advanced by green hydrogen projects.

2. Green hydrogen key to avoid climate change and to deliver on SDGs

The development of green hydrogen projects (including their associated energy supplies, electrolyser, and transportation infrastructure) has the potential to tackle climate change by reducing emissions from hard to decarbonise industries and advance sustainable development, by reliably integrating renewable energy into electricity grids generally across developing countries.

With many large-scale projects planned in emerging and developing economies, there is an increasing impetus for the green hydrogen industry to promote the achievement of several of the 17 Sustainable Development Goals ("SDGs").[3]

As developing countries consider hosting projects that produce green hydrogen and its derivatives for export and consumption to decarbonise the economies of more developed countries, it is also important that citizens in host countries benefit from such projects.

[2] Green Hydrogen Standard, https://greenhydrogenstandard.org/
[3] Adopted on October 21, 2015, https://www.un.org/ga/search/view_doc.asp?symbol=A/RES/70/1&Lang=E

These projects can provide multiple co-benefits beyond a clean form of energy supply, including an improved electricity supply, fresh water, new employment,and new economic development opportunities generally.

A commitment to the achievement of the SDGs is particularly (but not only) relevant to emerging economic and developing countries, for which the need for funding support for sustainable development is particularly acute. Indeed, in one key respect, green hydrogen projects located in developing countries may have a marked competitive advantage: the availability of relatively abundant supplies of wind, sunlight, or hydro resources, and greater availability of undeveloped, unused land on which to place both the renewable energy projects and related infrastructure.[4]

In sum, green hydrogen projects could, if they follow international best practices and rigorous standards, significantly advance the achievement of the SDGs. This was confirmed by a poll of a number of acknowledged energy policy experts conducted by the International Renewable Energy Agency ("IRENA") as part of its *IRENA: Geopolitics/Hydrogen Factor* report.[5] A majority of the participants believe that overall, green hydrogen projects would have a positive impact on achieving SDGs.

The benefits of these projects in achieving the SDGs will only be realised, however, if they are well planned, appropriately executed, and operated in a way that is transparent to all stakeholders. This will not happen by sovereign fiat. While many governments at various levels - transnational, national, regional, and local – have expressed their commitment to ensuring that infrastructure projects generally achieve at least some of the SDGs, laws and regulations alone will not be enough to help spur development of SDG-congruent green hydrogen projects. The private sector will need to act responsibly and work with public and non-state actors to find innovative solutions to address the SDGs. Development finance institutions will also play a key role in catalysing private sector investments into projects that demonstrate high potential to contribute to sustainable development outcomes.

[4] KPMG, *Geographic Hydrogen Hotspots*, https://kpmg.com/xx/en/home/insights/2021/01/geographic-hydrogen-hotspots.html.
[5] IRENA (2022), *Geopolitics of the Energy Transformation: The Hydrogen Factor*, International Renewable Energy Agency, Abu Dhabi ("*IRENA: Geopolitics/Hydrogen Factor*"), *p. 93,* https://www.irena.org/publications/2022/Jan/Geopolitics-of-the-Energy-Transformation-Hydrogen

The need to align existing financing and regulation of infrastructure development and operation to achieve the SDGs is a recognized global challenge.[6] Green hydrogen projects present additional challenges given that the regulatory regimes governing their construction and operation in many jurisdictions globally (i.e. not just in developing countries) are at best evolving. This is typically so because of the relative novelty of the green hydrogen sector, the rapid developments taking place in this space, the cost drop of the relevant technologies, and the projected huge scales involved.[7]

Thus, the extent to which a particular green hydrogen project ultimately achieves any particular SDG will largely depend on project-specific contractual terms among the relevant parties, including developers; financing partners; offtakers; engineering and procurement contractors; development agencies (multilateral, national and regional); and host communities.

> *"We shall deliver Namibia's Green Hydrogen strategy, outlining a clear pathway to unlocking even greater investments and to establishing Namibia as a regional and global decarbonization champion."*
>
> **H.E. Dr Hage G. Geingob**, President of the Republic of Namibia

> *"Accelerating Green Hydrogen is a critical agenda for Africa and for Mauritania. We have high ambitions to become a globally leading producer of green hydrogen, like other African countries."*
>
> **H.E. Isselmou Ould Mohamed M'Bady**, Minister of Finance, Mauritania

[6] See e.g., Kitty van der Heijden and Manish Bapna, *Now Comes the Hard Part: 4 Key Challenges to SDGs*, World Resources Institute (2015), *at* https://www.wri.org/insights/now-comes-hard-part-4-key-challenges-sdgs; *UNCED, Agenda 21, U.N. Doc. A/CONF.151.26 (1992), 8.5(g), https://sustainabledevelopment.un.org/content/documents/Agenda21.pdf;* United Nations, Inter-agency Task Force on Financing for Development, *Financing for Sustainable Development Report 2021,* pp. (New York: United Nations, 2021), https://developmentfinance.un.org/fsdr2021.

[7] *Innovation and Industrial Policies for Green Hydrogen*, Emile Cammeraat, Antoine Dechezleprêtre, and Guy Lalanne (OECD), February, 2022, https://www.oecd-ilibrary.org/science-and-technology/innovation-and-industrial-policies-for-green-hydrogen_f0bb5d8c-en.

3. Where green hydrogen can contribute the most

The green hydrogen economy can in particular contribute to the SDGs associated with energy, water, employment, infrastructure development and food security. These include:

13 CLIMATE ACTION	**SDG 13**: Take urgent action to combat climate change and its impacts
7 AFFORDABLE AND CLEAN ENERGY	**SDG 7**: Ensure access to affordable, reliable, sustainable and modern energy for all
6 CLEAN WATER AND SANITATION	**SDG 6**: Ensure availability and sustainable management of water and sanitation for all
8 DECENT WORK AND ECONOMIC GROWTH	**SDG 8**: Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all
9 INDUSTRY, INNOVATION AND INFRASTRUCTURE	**SDG 9**: Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation
2 ZERO HUNGER	**SDG 2**: End hunger, achieve food security and improved nutrition and promote sustainable agriculture

The SDG framework can be used to analyse almost any issue, as the goals are broad and are accompanied by more detailed, specific targets.[8] As a general principle for meeting a particular SDG target, one should identify the core competencies and attributes of an industry or project that have the most potential to meet such target, through beneficial investments, services or products.[9] The key question is how the industry, company or project can apply its comparative advantage, capabilities and skills to contribute to the achievement of the SDG, while also ensuring that the investments, services, or products are developed and delivered in ways that minimise any negative social and environmental impacts.

Consulting stakeholders to identify sustainable development targets.

Consultation with key stakeholders in host countries, from government, industry, civil society and local communities is key to understanding which sustainable development targets align the most with national and local priorities. Communities in particular should be consulted from the outset, both substantively regarding a green hydrogen project's costs and benefits, and procedurally to ensure that they are heard, understood and valued sufficiently to obtain a social license to operate. Further information on this is available in the Green Hydrogen Contracting Guidance on Community consultation and transparency. Drawing on the experiences from the extractive industries, "community development agreements" or "local benefit agreements" have the potential to support positive socioeconomic development outcomes and can be used to create a binding framework within which certain benefits that result from the green hydrogen projects may be shared.

For example, the German organisations Brot for die Welt and Heinrich Böll Stiftung undertook a consultation with civil society organisations in Argentina on their views on the role of green hydrogen in their economy. The consultation found that most of those consulted agreed that green hydrogen production should in its initial phase be export-oriented, provided there would be a clear plan to facilitate domestic use, industrial development and safeguarding the environment. Stakeholders also saw the potential of green hydrogen to contribute to energy storage, reduce renewable energy intermittency, and improved water desalination and purification technologies. Such stakeholder feedback provides a valuable starting point for identifying priority sustainable development targets.

[8] United Nations Department of Economic and Social Affairs, https://sdgs.un.org/goals
[9] Global Reporting Initiative and United Nations Global Compact (2018), Integrating the SDGs into corporate reporting: a practical guide, https://unglobalcompact.org/library/5628

SDG 13: Take urgent action to combat climate change and its impacts[10]

The green hydrogen industry is an essential element to decarbonize the 13-18% of industrial uses for the burning of fossil fuels which cannot be electrified, as well as other sectors of the economy that rely on hydrogen which have historically been fossil fuel based.

In some sectors of the economy hydrogen is expected to play a significant role, substantially displacing GHG-intensive energy sources. For example, some have estimated that by 2050, 25% of aviation's energy demands will be met by hydrogen.[11]

The rapidly reduction in costs of renewable energy, and electrolysers are also expected to make green hydrogen competitive with hydrogen derived from fossil fuels by 2030.[12]

Clear and globally accepted definitions of green hydrogen and low emissions thresholds/carbon intensity are essential for green hydrogen to positively impact of SDG 13. The Green Hydrogen Standard requires that green hydrogen projects operate at no more than 1 kg CO2e per kg of hydrogen.[13] According to IEA, IRENA and the UNFCCC, low-carbon and renewable hydrogen will need to achieve verifiable low carbon intensities that trend towards near zero by 2030.[14] Additionally, it is critical that methane and hydrogen leakage is minimised to near zero, if not completely avoided.

The key to ensuring that green hydrogen projects deliver on their promise to further SDG 13 through minimal carbon intensity will be the establishment of specific requirements that the renewable energy ultimately comes from newly built projects, whose output is generated temporally and geographically close in time and location, respectively, to the associated electrolysers' electricity consumption (see box on

[10] See the International Institute for Sustainable Development Tracker on SDG 13 here.
[11] Mission Possible Partnership, *Ten Critical Insights On The Path To A Net-Zero Aviation Sector* (2021), https://missionpossiblepartnership.org/wp-content/uploads/2021/10/MPP-Aviation-Transition-Strategy-2021.pdf.
[12] IRENA (2021), *Making the breakthrough: Green hydrogen policies and technology costs, International Renewable Energy Agency, Abu Dhabi.*, https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2020/Nov/IRENA_Green_Hydrogen_breakthrough_2021.pdf?hash=40FA5B8AD7AB1666EECBDE30EF458C45EE5A0AA6&la=en
[13] https://greenhydrogenstandard.org/
[14] UN Breakthrough Agenda (2022), *UN Breakthrough Agenda Report 2022 (p. 56),* https://climatechampions.unfccc.int/wp-content/uploads/2022/09/THE-BREAKTHROUGH-AGENDA-REPORT-2022.pdf

additionality). The European Union has already taken this step,[15] while the United States is still considering it as part of its implementation of the 2022 Inflation Reduction Act (which includes significant tax incentives for green hydrogen projects).[16]

A vivid example of the positive impact of green hydrogen on SDG 13 is the European Union's hydrogen strategy, which aims to scale up the production and use of green hydrogen in Europe. The strategy includes targets to install at least 40 GW of electrolysers in the EU by 2030 and to produce up to 10 million tonnes of renewable hydrogen by the same year. This initiative has a strong potential to contribute towards reducing greenhouse gas emissions and supporting the transition to a low-carbon economy.

Several countries have included green hydrogen as a major enabler of their net-zero goal, including China and France, who have defined emissions reduction targets through production of green hydrogen in their roadmaps. China's plan on the development of green hydrogen energy for the period of 2021-2035, aims to enable a carbon dioxide emission reduction of 1 million to 2 million tonnes per year.[17] France's Plan 2030 has the potential to reduce emissions by 35% by 2030, equivalent to 6 Metric tonnes of CO2 emission by 2030[18]. If the six member countries of the African Green Hydrogen Alliance (Egypt, Kenya, Mauritania, Morocco, Namibia and South Africa) realise their green hydrogen potential, it could reduce CO2 emissions amounting to 6.5 billion metric tonnes by 2050.[19]

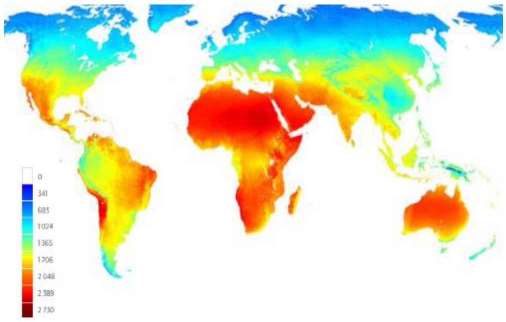
[15] Green Hydrogen Organization, *GH2 statement on new EU rules defining green hydrogen*, https://greenhydrogenstandard.org/news/gh2-statement-new-eu-rules-defining-green-hydrogen (discussing new rules issued pursuant to the EU's Renewable Energy Directive).
[16] NRDC, *Success of IRA Hydrogen Tax Credit Hinges on IRS and DOE*, (discussing pending rules to be issued by the U.S. Internal Revenue Service and Department of Energy). *See* Rhodium Group, *Scaling Green Hydrogen in a post-IRA World* (March 16, 2023), https://rhg.com/research/scaling-clean-hydrogen-ira/ (discussing the extent to which the E.U. Rules could serve as a model for the U.S.).
[17] National Development and Reform Commission of the People's Republic of China (March 2022), *China's Action Plan for Carbon Emission Peaking and Carbon Neutrality*, https://en.ndrc.gov.cn/news/pressreleases/202203/t20220329_1321487.html
[18] Présidence de la République (2021), *Feuille de route pour l'hydrogène - Vers une filière hydrogène durable en France*, https://www.ecologie.gouv.fr/sites/default/files/Plan_deploiement_hydrogene.pdf
[19] Africa Green Hydrogen Alliance (2022), Africa's Green Hydrogen Potential, https://gh2.org/sites/default/files/2022-11/Africa%27s%20Green%20Hydrogen%20Potential.pdf

SDG 7: Ensure access to affordable, reliable, sustainable and modern energy for all[20]

There are clear opportunities for green hydrogen to accelerate renewable energy investment, market development, energy access and grid stability. One of the core targets of SDG 7 is to ensure that public and private sector efforts seek to increase substantially the share of renewable energy in the energy mix, both locally and globally.

On the other hand, the energy intensive process of producing green hydrogen has the potential to negatively impact renewable energy access and increase energy bills, particularly in developing countries where energy access may already be an issue. In these countries, governments and project developers will need to ensure that green hydrogen development contributes positively to SDG 7.

Many developing countries with excellent renewable energy resources have inadequate electricity supplies, and unreliable supporting grids. To address this, renewable energy projects (especially onshore and offshore wind and solar) constructed together with green hydrogen projects could be designed specifically to include capacity to also supply electricity to currently underserved local and regional end users.



Annual average global horizontal irradiation (kWh/m2), *IRENA: Geopolitics/Hydrogen Factor*, p. 33.

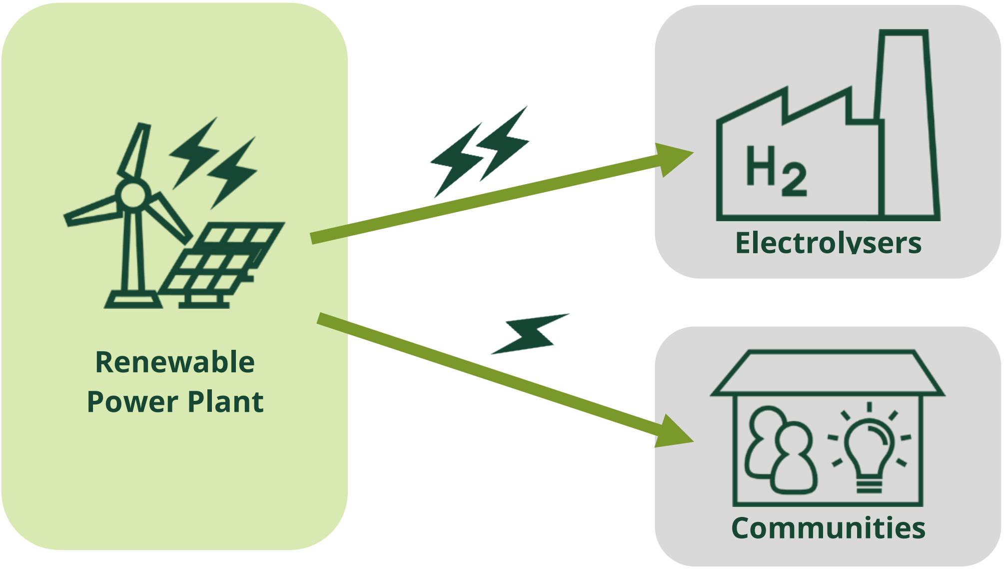
Where feasible, project developers could be incentivised to build their co-located renewable energy plant as soon as possible, to supply the nearby energy grids depending on their absorption capacity. Project developers could also be incentivised to oversize the renewable energy facilities, to provide sources of new, clean energy for surrounding communities at affordable prices. If the renewable electricity is purchased by the government or a public utility early on while the electrolysis plant is being set up, it would help derisk the renewable energy component of the green hydrogen project until the whole value chain is built.

[20] See International Institute for Sustainable Development Tracker on SDG 7 here.

It is critical to avoid local communities becoming unduly dependent over the long term on services provided by large-scale projects. An exit strategy should be put in place. Governments could incentivize project developers to supply electricity to communities for the initial project stages, while a plan is put in place for local authorities and communities to eventually cover the costs of their portion of the project's output.

Green hydrogen projects themselves could also serve to increase grid reliability and resilience, as backup energy for renewables-based power systems to help balance supply and ameliorate the intermittency of wind and solar projects, while helping to decarbonize local grids.[21]

Renewable energy supply for green hydrogen production



For example, in South Africa green hydrogen production could be part of a holistic set of technologies to allow for a renewable energy-based power system to be adequately balanced (using hydrogen as an energy carrier and for energy storage).[22] HDF Energy's *Renewstable* model power plants are a prime example. These power plants are composed of an intermittent renewable source and a long-term on-site hydrogen energy storage. The power plants would provide on demand electricity from local sources of renewable energy (wind or solar), combined with high power fuel cells.

[21] World Economic Forum, W*hy We Can't Ignore Green Hydrogen in the Clean Energy Mix*, (March 16, 2023 ("Using electrolysis, hydrogen can balance out supply and demand on electrical grids and respond better to seasonal adjustments because of its storage capacity once compressed").
[22] Brot für die Welt and Heinrich Böll Stiftung (2022), Green Hydrogen: Key Success Criteria For Sustainable Trade & Production: A Synthesis Based On Consultations in Africa & Latin America https://hk.boell.org/sites/default/files/importedFiles/2022/11/17/green-hydrogen-bericht.pdf

Ultimately, renewable energy power plants in South Africa, with 1500 MW capacity could be deployed with more than 3500 MWh of hydrogen-based long-term energy storage to supply stable energy to more than 1.4 million inhabitants.[23]

In India, the government is also planning to use green hydrogen to support the development of decentralized and off-grid energy systems, particularly in rural areas with limited access to energy and clean water.[24]

"Additionality" – what is it and why it matters

Green hydrogen is hydrogen produced through the electrolysis of water with 100% or near 100% renewable energy with close to zero greenhouse gas emissions. Some green hydrogen projects are "off-grid", i.e., they have their own dedicated supply of renewable electricity. However, a substantial proportion of green hydrogen projects are "on-grid", adding to the demand for electricity, often in cases where renewable energy supplies are limited. The concern is that the additional demand from green hydrogen production will reduce renewable energy consumption in other sectors (which can use renewable energy more efficiently) delaying the overall greening of the grid and raising prices for consumers, whilst driving up total emissions. "Additionality" for grid-connected green hydrogen means production is accompanied by an additional source of renewable energy capacity, and the degree to which this additional capacity needs to be matched in space (geographical correlation) and time (temporal correlation).

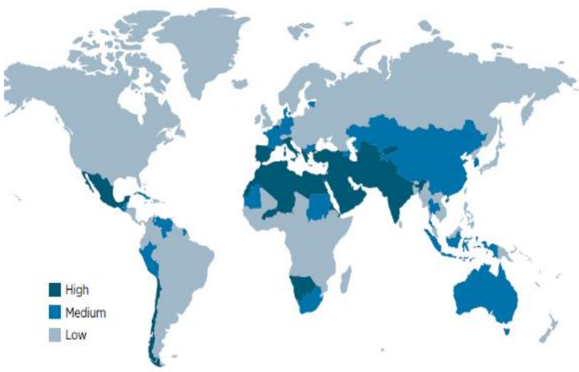
For example, the European Union has adopted a Delegated Act under the Renewable Energy Directive requiring that new additional renewable electricity is deployed to produce green hydrogen and that the renewable electricity is matched with electrolysers in terms of timing and location. The rules include a transition period where "additionality" restrictions are waived for projects which begin production before 2028.

[23] https://www.renewstable-swakopmund.com/
[24] Government of India, Ministry of New and Renewable Energy, "National Green Hydrogen Mission", January 2023. https://mnre.gov.in/img/documents/uploads/file_f-1673581748609.pdf

SDG 6: Ensure availability and sustainable management of water and sanitation for all[25]

One of the key targets of SDG 6 is to by 2030 achieve universal and equitable access to safe and affordable drinking water for all. In light of the technology deployed in green hydrogen projects, an indirect benefit of these projects could be the promotion and local realisation of this goal.

Currently, the most common technology for producing green hydrogen involves the use of electrolyser technology, which in turn requires fresh water. Many of the best renewable energy resource areas (onshore wind and solar), especially in developing countries, are water stressed. According to IRENA, the projected 409 million tonnes of green hydrogen needed by 2050 to align with a 1.5°C scenario would require around 7–9 billion cubic metres of water a year – less than 0.25% of current freshwater consumption. This is lower than water required to produce blue hydrogen.[26]



Heat map of water stress levels, *IRENA: Geopolitics/Hydrogen Factor*, p. 99.

Green hydrogen "could give a spur to the desalination industry, resulting in a massive scale-up of desalination capacity. This could also increase the supply of freshwater for other purposes beyond electrolysis or drive down the cost of desalination."[27] Brot für die Welt and Heinrich Böll Stiftung recommends that new water sources (e.g. desalination plants) developed for production of hydrogen "should also contribute to reducing water stress and increasing water availability for the local population in the production region as a whole."[28]

[25] See International Institute for Sustainable Development Tracker on SDG 6 here.
[26] IRENA (2022), *Geopolitics of the Energy Transformation: The Hydrogen Factor*, International Renewable Energy Agency, Abu Dhabi ("*IRENA: Geopolitics/Hydrogen Factor*"), p. 98, https://www.irena.org/publications/2022/Jan/Geopolitics-of-the-Energy-Transformation-Hydrogen
[27] *IRENA: Geopolitics/Hydrogen Factor,* p. 99
[28] Brot für die Welt and Heinrich Böll Stiftung (2022), *Green hydrogen: Key Success Criteria for Sustainable Trade & Production,* („die Welt and Stiftung"), p. 26, https://hk.boell.org/sites/default/files/importedFiles/2022/11/17/green-hydrogen-bericht.pdf

Fresh water could be produced by desalination plants. Such plants, along with electrolyser installations and the renewable energy projects that would supply power to both, could be designed with sufficient capacity to also produce fresh water for supply to state/private water utilities and ultimately local community members and other affected stakeholders.

In Namibia, the project developer Hyphen is developing an integrated green hydrogen facility that will have a renewable generation capacity of 5 GW and an electrolyser capacity of 3 GW, with surplus electricity capacity to be fed into the Namibian grid and potentially into the regional power pool. The project will use desalinated water, part of which will be supplied to communities in nearby Luderitz.

In Brazil, civil society stakeholders have identified the potential for the green hydrogen industry to contribute to increasing access to desalinated water in regions with a shortage of drinking water.[29]

Morocco, a water scarce country with limited access to freshwater resources, has implemented policies to support the development of green hydrogen in its national roadmap, to generate electricity and green ammonia, which can be used to power desalination plants and water treatment facilities, providing clean and sustainable sources of water for communities[30].

Additionally, green hydrogen production has the potential to be integrated with wastewater treatment (which historically has relied on fossil fuels for power), providing a sustainable source of energy while also treating water.[31]

To enhance positive impacts, early on in project development the government (national or local, as appropriate) and project developers could undertake assessments of opportunities to generate co-benefits for local communities through provision of drinking water, water for irrigation, and/or water treatment.

Where feasible, project developers could consider requiring desalination plants to be oversized, with excess capacity feeding local needs. For example, an additional 10% capacity could provide additional clean water to surrounding communities at affordable prices. "The water supply system could be expanded to cater for other water uses (e.g.,

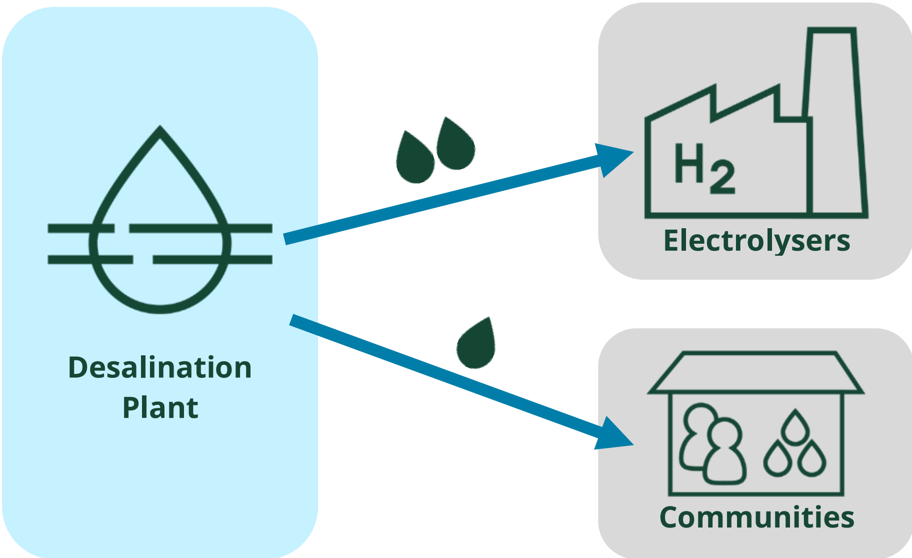
[29] Brot für die Welt and Heinrich Böll Stiftung (2022), Green Hydrogen: Key Success Criteria For Sustainable Trade & Production: A Synthesis Based On Consultations in Africa & Latin America https://hk.boell.org/sites/default/files/importedFiles/2022/11/17/green-hydrogen-bericht.pdf

[30] Ministry of Energy, Mines and Environment of Morocco, "Feuille de route de hydrogène vert", (2021) https://www.mem.gov.ma/Lists/Lst_rapports/Attachments/36/Feuille%20de%20route%20de%20hydrog%C3%A8ne%20vert.pdf

[31] Mackenzie, Gordon A. et al. "Green Hydrogen Production and Applications: Opportunities and Challenges." Reviews in Chemical Engineering, vol. 37, no. 4, 2021, pp. 819-840, doi: 10.1515/revce-2020-0082.

sanitary) at a relatively small cost penalty for the hydrogen but providing the economies of scale needed to achieve low water costs."[32] While desalination of seawater by itself is relatively expensive, it only adds a marginal cost of USD 0.02–0.05 to the cost of a kilogramme of green hydrogen.[33]

Water supply for green hydrogen production



A key question will be how to allocate costs of such expanded capacities, between government (central and local), project developers and development finance institutions. As discussed in the section on SDG 7, an exit strategy will be key to avoid dependencies and ensure that the development outcomes are truly sustainable and generate value in the long-term. For instance, project developers could be incentivized to supply clean water for the first 5-10 years of the project, while a plan is put in place for local authorities and communities to eventually fund their portion of the project's output, or build their own desalination or water distribution facility with support from the government and project developers.

Through such efforts, green hydrogen operations can further two additional targets of SDG6. First, the development of the technology on which green hydrogen projects rely may expand international cooperation and capacity-building support to developing countries in water- and sanitation-related activities and programmes, including water harvesting, desalination, water efficiency, wastewater treatment, recycling, and reuse technologies. Second, and equally important, the projects will support and strengthen

[32] IRENA, *Global Hydrogen Trade to Meet the 1.5°C Climate Goal: Part III – Green Hydrogen Cost and Potential.* (2022), p. 35, https://www.irena.org/publications/2022/May/Global-hydrogen-trade-Cost.
[33] IRENA (2022), *Geopolitics of the Energy Transformation: The Hydrogen Factor*, International Renewable Energy Agency, Abu Dhabi ("*IRENA: Geopolitics/Hydrogen Factor*"), p. 98, https://www.irena.org/publications/2022/Jan/Geopolitics-of-the-Energy-Transformation-Hydrogen

the participation of local communities in improving water and sanitation management by involving them as key stakeholders in the green hydrogen operations.

To reduce negative impacts on water resources, green hydrogen production should generally minimise water use to the extent possible and of course restrain from using freshwater in areas with water stress.

To ensure that the above goals are met, governments should ensure that project developers take appropriate measures to potentially negative impacts through both their laws and contractual arrangements with project developers.

The Green Hydrogen Standard provision on water use and quality (Requirement 5B) could be considered. The objective of this provision is to ensure that green hydrogen projects address the availability and sustainable management of water and sanitation, particularly incorporating the need to address risks of reducing water access/exacerbating water stress, including providing extra desalination capacity where applicable.

The Standard requires a publicly accessible evaluation of the project's utilisation of water and the project's approach to wastewater treatment and water pollution. Moreover, ongoing public access to information will allow stakeholders to track water use throughout the green hydrogen production process.

The project operator "must demonstrate that it has identified and implemented technically and financially feasible and cost-effective measures for improving efficiency in its consumption of water, particularly in risks associated with water access and water stress" (Requirement 5B). Such measures will integrate the principles of cleaner production into product design and production processes with the objective of optimising water consumption and minimising water pollution. A clear plan for the responsible management (dilution and diffusion) of brine from desalination is also necessary.

GH2 Standard requirements for desalination

Where desalination takes place, the G2H Standard requires that project operators demonstrate that desalination plans do not have a negative effect on the water source. This could include providing:

- A description of how the project interacts with water, including how and where water is withdrawn, consumed, and discharged, and the water-related impacts caused or contributed to, or directly linked to the project
- A description of total water consumption from all areas, with a focus on areas with water stress;
- A description of how water-related impacts are addressed, including how the project operator works with stakeholders to steward water as a shared resource;
- A description of any minimum standards set for the quality of effluent discharge, and how these minimum standards were determined.

SDG 8: Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all

Among other things, SDG 8 seeks to promote the advancement of higher levels of economic productivity through diversification, technological upgrading and innovation, including through a focus on high value-added and labour-intensive sectors. It also indicates that public and private sector stakeholders must improve, progressively through 2030, resource efficiency in consumption and production and endeavour to decouple economic growth from environmental degradation.

Green hydrogen projects have the potential to contribute towards all these objectives. As a premise, the development of renewable energy and hydrogen production projects (including associated infrastructure) will increase the diversity of local and domestic economies. Second, the production plants will also introduce new and cutting-edge technologies to developing countries. Thus unlike the historic operation of fossil fuel-based energy generation plants, properly developed and sustainable green hydrogen operations can mitigate environmental impacts from the outset.

Given the expected huge scale-up of green hydrogen production over the next ten to thirty years, the opportunities for job creation are ample. For example, IRENA has estimated that the need for electrolysers alone "could directly spur the creation of 2 million jobs worldwide from 2030. "[34]

While there are high expectations of potential job creation in the green hydrogen industry, it should be recognized that many of the jobs will be during construction and thus temporary. Of the 4.2 million jobs green hydrogen projects can directly generate in the six founding member countries of the Africa Green Hydrogen Alliance[35], 1.2 million and 390,000 jobs are expected to be provided during construction of renewable energy projects and electrolyser infrastructure, respectively, while overall, the recurrent benefits of operating this collective new infrastructure could support about 2 million jobs[36]

In addition to direct construction, operation and maintenance jobs, green hydrogen projects typically will be built as part of industrial hubs that would likely include ancillary facilities such as ammonia fertilizer, green steel, and other industries that could take hydrogen for various end uses. These facilities would all benefit from co-location to minimize transportation costs, while adding to the potential for new employment opportunities.

According to die Welt and Stiftung, (citing IRENA), "policy makers should assess the value that the hydrogen sector would add to the economy and its effect on associated industries, quantifying the number of jobs generated in equipment manufacturing, construction and operation, and indirectly in the supply chain and supporting industries. [...] In addition, the local workforce needs to be able to perform the new jobs that will be created in these activities, and even in regulating the industry. Countries will therefore need education and training programmes to ensure a match between the skills needed and those currently available."[37]

[34] *IRENA: Geopolitics/Hydrogen Factor*, p. 93.
[35] Egypt, Kenya, Mauritania, Morocco, Namibia and South Africa, https://gh2.org/africa-green-hydrogen-alliance-agha
[36] Africa Green Hydrogen Alliance (2022), Africa's Green Hydrogen Potential, p. 28, https://gh2.org/sites/default/files/2022-11/Africa%27s%20Green%20Hydrogen%20Potential.pdf
[37] Brot für die Welt and Heinrich Böll Stiftung (2022), Green Hydrogen: Key Success Criteria For Sustainable Trade & Production: A Synthesis Based On Consultations in Africa & Latin America https://hk.boell.org/sites/default/files/importedFiles/2022/11/17/green-hydrogen-bericht.pdf

In Plan France 2030[38], France aims to become a leader in green hydrogen by developing a fully integrated and competitive sector that will create 50,000 to 150,000 jobs by 2030. India's National Green Hydrogen Mission includes an impact target of creating 600,000 new jobs in the sector by 2030[39].

The United States 2022 Inflation Reduction Act[40] includes robust tax credits for various forms of renewable energy, including green (and other forms of low carbon intensity) hydrogen. The full value of these tax credits is only reached when certain prevailing wage requirements, and goals for deployment in economically distressed areas, are met, thus contributing towards SDG 8 by stimulating technological innovation and creating decent work and employment opportunities throughout the country. Even before the passage of the IRA, construction of low carbon hydrogen projects was estimated to help create as many as 700,000 new jobs in the US by 2030.[41]

SDG 9: Build resilient infrastructure, promote inclusive and sustainable industrialisation and foster innovation[42]

The positive impact which the green hydrogen may have on SDG 9 are easy to identify. As a premise, SDG 9 advocates for the development of quality, reliable, sustainable and resilient infrastructure, including regional and transborder infrastructure, to support economic development and human well-being, with a focus on affordable and equitable access for all. Owing to the novel nature of the green hydrogen industry, developers will necessarily be establishing new infrastructure which will enable the further development of local economies.

[38] Présidence de la République. "Feuille de route pour l'hydrogène - Vers une filière hydrogène durable en France," Elysée Palace, October 2021. https://www.elysee.fr/front/pdf/elysee-module-18543-fr.pdf
[39] Government of India, Ministry of New and Renewable Energy, "National Green Hydrogen Mission", January 2023. https://mnre.gov.in/img/documents/uploads/file_f-1673581748609.pdf
[40] The IRA has been characterized as "the largest single piece of climate legislation ever passed in the United States [whose] incentives . . . will affect the entire energy sector, from producers of raw materials to end-use consumers." Neil R. Mehrotra and Sanjay Patnaik, *How much will the climate provisions in the IRA cost, and what will they achieve?* (Brookings, April 27, 2023), https://www.brookings.edu/podcast-episode/how-much-will-the-climate-provisions-in-the-ira-cost-and-what-will-they-achieve/.
[41] "Road Map to a U.S. Hydrogen Economy: Reducing emissions and driving growth across the nation," 2020, Page 7, https://www.fchea.org/us-hydrogen-study
[42] See the International Institute for Sustainable Development Tracker on SDG 9 here.

According to Brot for die Welt and Heinrich Böell Stiftung, writing about the prospects for green hydrogen projects in South Africa, such investments "can incentivise and enable investment in local infrastructure – both where existing networks will need to be augmented, and where new infrastructure projects require local anchor investments to make them financially viable. This would apply in the case of new port development in the Northern Cape, noting complexities and potential negative impacts of this development with caution."[43]

To the extent such projects are also designed for the export of hydrogen (in compressed or liquefied form, or converted to another carrier (ammonia, LOHC, e-methane), opportunities to build relevant conversion facilities and improve port facilities generally, as well as for further employment, are likely. As part of such projects, workforce training programs can be incorporated into development plans, with new skill sets transferrable to other industrial jobs.

Opportunities for governments and public finance institutions to offer financial incentives in the short term and gain economic benefits through taxes and other infrastructure development, can (and should) be included in green hydrogen strategies and policies.[44]

Each of these benefits are particularly relevant to developing countries, especially to the extent that they may foster economic development that might have otherwise not occurred.

India is good example of a key developing country that has the potential to benefit from the positive impacts of green hydrogen on SDG 9. Under the National Green Hydrogen Mission, the Indian cabinet approved a total of €2.24 billion for the initial outlay, which includes €1.98 billion for the Strategic Interventions for Green Hydrogen Transition Programme (SIGHT), that will fund the research and domestic manufacturing of electrolysers by 2030[45].

[43] Brot für die Welt and Heinrich Böll Stiftung (2022), Green Hydrogen: Key Success Criteria For Sustainable Trade & Production: A Synthesis Based On Consultations in Africa & Latin America https://hk.boell.org/sites/default/files/importedFiles/2022/11/17/green-hydrogen-bericht.pdf
[44] This topic is further covered in Green Hydrogen Contracting Guidance on Fiscal Terms and Incentives (2023) https://gh2.org/sites/default/files/2022-12/GH2_Contracting%20Guidance_Fiscal%20Terms%20and%20Incentives_2022.pdf.
[45] Government of India, Ministry of New and Renewable Energy, "National Green Hydrogen Mission", January 2023. https://mnre.gov.in/img/documents/uploads/file_f-1673581748609.pdf

In Morocco, the hydrogen roadmap spotlights the development of a green hydrogen export industry and its derivatives, that will be made mainly through the establishment of maritime transport of synthetic liquid fuels, the deployment of port infrastructure as well as the production and storage infrastructures for export.[46]

SDG 2: End hunger, achieve food security and improved nutrition and promote sustainable agriculture[47]

Green hydrogen can be converted to ammonia and used to make fertilisers. Ammonia is a very effective fertilizer and is the second-most commonly produced chemical in the world. However, today most ammonia and fertilisers rely on access to natural gas and are produced with significant greenhouse gas emissions. A switch from fossil fuels to renewable energy, green hydrogen and green ammonia therefore has the potential to reduce dependence on fertiliser imports, enhance food security and reduce greenhouse gas emissions.

Current gas-based fertiliser production is also centralised in a relatively small number of locations and is price sensitive to the price of gas. This contributes to undermining food security in countries reliant on imports of fertilisers. Green fertilisers could be produced near markets in countries with renewable energy sources and increase food security. This will require that governments and the private sector urgently scale up large-scale renewable energy capacity and the production of green fertilisers in developing countries and emerging economies.

For example, in Kenya a 300MW green ammonia fertiliser facility is being developed by Fortescue Future Industries. The plant is aimed to be built by 2025 and will provide affordable green fertiliser to the domestic market and address food security. The plant is likely to use geothermal energy to produce the required green hydrogen, which would then be added to nitrogen from the air to make ammonia.

[46] Moroccan Ministry of Energy, Mines and Environment, "Feuille de route de hydrogène vert", (2021) https://www.mem.gov.ma/Lists/Lst_rapports/Attachments/36/Feuille%20de%20route%20de%20hydrog%C3%A8ne%20vert.pdf
[47] See the International Institute for Sustainable Development Tracker on SDG 2 https://sdg.iisd.org/sdgs/goal-2-zero-hunger/

4. Conclusion

If sustainable development concerns practices which allow the current generation to meet their development needs without depriving future generations of the ability to meet their needs, the component parts of green hydrogen operations (including renewable energy plants, electrolysers, and transport and export infrastructure) may comprise the quintessential example of a sustainable enterprise. Whether or not a specific project achieves this, will be a question of fact.

While it would not be possible or sensible to inscribe the targets which form part of the 17 UN SDGs as undertakings in the agreement that will regulate green hydrogen operations, the SDGs and their targets should be used to inform the content of specific undertakings. For example, the tenants of SDG 9 could be used when project developers negotiate the terms which will regulate the construction of the renewable facilities, hydrogen production plants, and related infrastructure. Likewise, SDG 8 could serve as the goal towards which public and private sector stakeholders must work when they agree on local content thresholds.

The success of any project will ultimately not depend on its ability to promote a single SDG. Rather, it will be evaluated on the sum of the environmental, social and economic impacts it as on the environment in which the project is established.

> *"Green hydrogen [is] the driving force of our energy system of the future. And I also strongly believe that Europe is never going to be capable to produce its own hydrogen in sufficient quantities [...] If around the Mediterranean, in the widest sense, we can create a diversified interdependence, which means that we all have a stake in this production, distribution, utilization of green hydrogen, this is the future, this is how you also create more stability in the geopolitical system. This is how you offer an enormous opportunity for the development of Africa — 600 million Africans who now have no access to energy will have access to electricity."*
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> **Frans Timmermans**, the EU's Europe's Commissioner for Climate Action