Climate Action Network
Discussion Paper: Renewable-based hydrogen
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Climate Action Network (CAN) is a global network of more than 1,900 civil society organisations in over 130 countries driving collective and sustainable action to fight the climate crisis and to achieve social and racial justice.

Summary

CAN is opposing any hydrogen derived from fossil fuels or nuclear energy, because these methods of production are fraught with risks to the climate and the environment. CAN also opposes any type of hydrogen blending as well as hydrogen combustion with fossil fuels, which will only extend fossil fuels and delay the necessary transition towards renewables.

CAN only supports renewable-based hydrogen, and its derivatives, produced by electrolysis powered by solar and wind energy primarily, provided that it doesn't come at the expense of decarbonizing the domestic power or ensuring access to renewable energy for all. CAN is supportive of renewable-based hydrogen use in applications where it is the most economically and technically viable option as a feedstock or energy carrier, while recognizing the need to prioritise direct electrification whenever possible and to implement demand-side and energy efficiency measures to minimise energy/hydrogen demand. This includes the use of renewable hydrogen to replace current fossil fuel-based hydrogen in industry and as a storage solution. In the transport sector, CAN acknowledges the potential of hydrogen and hydrogen-derived fuels in the decarbonization of segments that are hard to electrify (long-haul aviation and shipping), while pushing for research and measures to minimise energy consumption (e.g. more efficient technologies and behavioural changes such as reduced air travel). Even so, we note that hydrogen will likely only provide at most 10% of all energy used in a fully decarbonised global economy moving to 100% renewables.

CAN recognises the many social, economic, trade and environmental challenges associated with the build out of renewable hydrogen infrastructure and its expansion as an export commodity particularly in the Global South, and therefore demands sustainable, equitable and Just Transition principles, policies and practices wherever renewable-based hydrogen is being produced or used.

Introduction

Hydrogen is currently almost exclusively produced from fossil fuels (>99%) and is mainly used as basic raw material in a handful of industrial sectors including oil refining, fertilisers, plastics[1] and steel manufacturing. In such present-use sectors, to stay within the limits of the Paris Agreement, it is urgent to switch away from fossil-fuel based hydrogen and hydrogen derivatives towards renewable-based hydrogen. In "non-traditional" sectors that have been targeted for future hydrogen adoption and where direct electrification is not yet feasible, any hydrogen used should be renewable-based as well[2]. Hydrogen is also an electricity storage solution in countries with growing shares of weather-dependent renewables in the power mix, to avoid electricity being wasted during periods of over-production (>100%) from wind or solar sources, and in particular for long-term and seasonal storage.

This paper proposes principles for a responsible, sustainable and adequate production and use of hydrogen and hydrogen derivatives.

Energy savings and electrification need to be aligned. In line with its previous positions on energy efficiency[3], CAN reaffirms that when it comes to mitigation, energy efficiency and demand-side reduction measures are as important as the upscale of renewable energy. For hydrogen-consuming sectors, this includes for example: a) in agriculture: more efficient, responsible and reduced use of nitrogen/ammonia fertilisers in line with agroecological practices[4]; b) in industrial sectors such as steel and plastics: improved efficiency in production processes, higher recycling rates and strong circularity measures, increased material substitution, reduced production of unnecessary plastic products, etc.; c) in the transport and land planning sectors: modal shift away from private vehicles towards more walking, cycling, micro-mobility, ride-sharing and public transportation, air travel demand reduction, etc. Further, when viable, direct electrification is far more efficient in its use of renewable power and should be prioritised over the use of hydrogen and hydrogen derivatives, such as in the cases of home heating, water heating, power generation and road transport. This would minimise the risks associated with hydrogen production and avoid energy conversion losses.

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[1] In 2015, approximately 5% of global CO_2 emissions were caused by the production of plastics fossil fuels. Growing environmental footprint of plastics driven by coal combustion | Nature Sustainability

[2] Hydrogen demand is expected to increase from around 100Mt in 2021 to 430 Mt in 2050 in the latest IEA NZE scenario (IEA 2023, Net Zero Roadmap: A Global Pathway to Keep the 1.5 °C Goal in Reach – Analysis - IEA)

[3] https://climatenetwork.org/resource/global-targets-for-clean-renewables-and-energy-efficiency-must-stand-alongside-fossil-fuel-phase-out/ and https://climatenetwork.org/resource/can-position-energy-efficiency-and-conservation/

[4] Some members note that industrial nitrogen fertilisers should be phased out

Renewable-based hydrogen only. In sectors where hydrogen is currently used or could contribute to countries' mitigation pathways, the only acceptable means of production is via electrolysis from renewable sources of electricity, primarily solar and wind. If the electricity is taken from the grid, the grid should run on 100% renewable electricity. Hydrogen derivatives such as ammonia and methanol must also be produced from renewable-based hydrogen. Hydrogen must not be produced from or combusted with fossil fuels, with or without Carbon Capture and Storage (CCS)[5]. As per its position on nuclear[6] CAN strictly opposes hydrogen produced from nuclear electricity. CAN doesn't have a position on bioenergy but some members oppose hydrogen being produced from woody biomass in particular or any other bioenergy.

Hydrogen produced, blended or combusted with fossil fuels must not be considered a "transition fuel". The use of hydrogen or its derivatives alongside fossil fuel, e.g. for blending in gas networks or co-firing in coal or gas power plants, is more often than not presented as a "transitory" measure by governments and fossil fuel industries to supposedly kick-off the production of renewable hydrogen or with the promises of ultimately switching to renewable hydrogen only (or in the case of ammonia-coal co-firing, eventually mono-firing 100% ammonia). This is for example the case in Japan, which is strongly pushing for ammonia-coal co-firing as part of its national strategy and also pushing for this technology throughout Southeast Asia and South Asian countries[7]. On the contrary, continued or new investments in fossil-fuel based hydrogen or hydrogen blending or co-firing will only lock countries into unsustainable energy systems and delay the upscale of renewable energy, while having limited emissions reductions potential. CAN therefore strongly opposes hydrogen blending as well as hydrogen or ammonia co-firing coal or gas power plants, with or without CCS.

In addition, CAN is supportive of the demand that the development of renewable hydrogen projects should come with the deployment of *additional* renewable electricity generation capacities to be fed into national grids, which would accelerate the decarbonisation of the power sector domestically.

Adequate and targeted uses of hydrogen. The role of renewable-based hydrogen should be restricted to "no-regret" sectors, where direct electrification is not yet possible and after implementing demand-side and energy efficiency measures to minimise

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[5] https://climatenetwork.org/resource/can-position-carbon-capture-storage-and-utilisation
[6] https://climatenetwork.org/resource/can-position-sustainable-energy-world-without-nuclear-power-march-2015/
[7] https://www.ammoniacoalfiring.info/

energy demand. However, in certain end-use applications, the life cycle carbon and economic benefits of hydrogen over other technologies are still uncertain, such as high temperature industrial processes and certain modes of transport. Further studies are needed to identify where hydrogen is the most technically, economically and environmentally appropriate solution, and where alternative technologies are more effective, including direct electrification and/or alternatives that reduce or eliminate the need for hydrogen, such as electrolytic reduction in the steel sector.

Priority should be given to replacing fossil-fuel based hydrogen with renewable-based hydrogen in industrial sectors where hydrogen is currently used as a feedstock (refineries, ammonia, methanol and steel). Renewable-based hydrogen is particularly expected to play a greater role in the decarbonisation of the steel sector and replacing coking coal, through the hydrogen direct reduced iron production route.

In the power sector, the increasing share of variable renewable energy, particularly solar and wind, will require the deployment of storage solutions to store electricity during periods of excess generation and avoid losses. For short to medium term storage, different options exist such as batteries or hydro-pumped storage and the use of hydrogen in one option to be considered alongside others depending on local infrastructure, hydropower capacities, needs, etc. For long-term (weeks or months) and seasonal storage of electricity, renewable-based hydrogen is also a potential option[8], although the safety and impacts of considered storage solutions (salt caverns, old unused fossil gas tanks, depleted aquifers etc.) will have to be duly assessed and taken into consideration.

For land transport, light duty electric vehicles are far more efficient and becoming cheaper than vehicles based on direct hydrogen combustion or fuel cells and should therefore be prioritised, although in transport segments where electrification is more challenging (e.g. due to batteries' weights, charging infrastructures, etc.), fuel cell road vehicles could play a role, such as with heavy-duty vehicles like tractors. In the aviation and maritime sectors, electric aircrafts or vessels are not yet commercially available and are not foreseen to be used for long-distance trips in the near-term[9]. Renewable-based hydrogen and hydrogen-derived fuels (e.g. e-ammonia, e-methanol) have the potential to contribute to the decarbonization of the shipping and aviation sectors, notably for long-haul travel. However, the production of these e-fuels require large amounts of renewable electricity and are associated with important conversion losses and cannot

[8] IPCC AR6 WGIII, Mitigation of Climate Change, Table 6.5. See also e.g. https://www.sciencedirect.com/science/article/pii/S1364032121009035

[9] https://theicct.org/publication/beyond-road-vehicles-survey-of-zero-emission-technology-options-across-the-transport-sector/

be seen as a “silver bullet”. Energy efficiency solutions as well as alternative/additional technological solutions should be further researched and deployed (e.g. wind-powered cargo ship), along with reduced demand (notably for air travel).

In the building sector, in addition to strong refurbishment towards low/zero energy housing, using electric heat pumps is much more efficient for heating and cooling than using hydrogen via existing gas supply infrastructure and should therefore be prioritised[10].

Hydrogen production, storage, transport and use should follow the highest social and sustainability standards. Governments and industries must ensure that all emissions throughout the entire value chain are minimised and taken into account when designing regulations, certifications and standards for renewable hydrogen. This includes CO2 emissions and H2 emissions/leakages across the whole supply chain as well as health-harming NOx emissions during combustion. Because of its high volatility and flammability, high safety standards must be upheld for the transport, storage and use of hydrogen. Hydrogen is an indirect greenhouse gas that interacts with other gases (methane, ozone, water vapour) to increase their global warming potential. Its global warming potential on a 20 year timeframe could be as high as 44 and about 12 times higher than CO2 per unit over 100 years[11].

The production of renewable-based hydrogen will entice an increased demand for resources such as additional land use for wind and solar installations, carbon for the production of hydrogen-derived fuels, water for electrolysers, minerals for wind and solar plants as well as electrolysers and fuel cells. The highest social and sustainability standards should be applied to all these resources.

Land rights and rights of communities affected by hydrogen-related infrastructure (electrolysers, desalination plants, wind and solar farms) should be duly respected, including but not limited to the principle of free and prior informed consent of local land users[12]. This is essential to uphold environmental justice, because communities of colour and low-wealth communities have historically been disproportionately harmed by the biased siting of energy infrastructure. It must be assured that hydrogen buildout will not perpetuate the same injustices. Civil society inclusion and participation should also be supported, from the early stages of the project.

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[10] https://h2sciencecoalition.com/blog/hydrogen-for-heating-a-comparison-with-heat-pumps-part-1/
[11] a) Warwick, N. et al. 2022, Atmospheric implications of increased Hydrogen use - GOV.UK;
b) Sand, M. et al. 2023, A multi-model assessment of the Global Warming Potential of hydrogen | Communications Earth & Environment (nature.com)
[12] See CAN’s position on “The transition to 100% renewable energy must be just, equitable and rapid“

With regards to water, for every kilogram of hydrogen produced, about 9 kg of freshwater are used. Where possible, renewable-based hydrogen should reduce freshwater demand per unit of energy produced compared to fossil fuels or/and nuclear. Today, renewables-based hydrogen already uses less than 30% to 50% of the freshwater per unit of energy than fossil fuels or/and hydrogen produced from fossil fuels[13]. The use of water for hydrogen production should not negatively impact the water situation and lead to a depletion of water supply. Some organisations also note that *additional* desalination plants should be built for hydrogen projects and should benefit local communities as well, providing that strong sustainability standards are in place, notably to deal with brine disposal.

If pursued, hydrogen trade should be fair and sustainable and benefit local communities[14]. Hydrogen trade is anticipated to be predominantly local or regional rather than international, because hydrogen is not a commodity that can be easily transported[15]. However, we observe an increasing number of international trade announcements, which carries the risk of investments becoming stranded if the future hydrogen export demand does not meet current and uncertain projections, as well as creating new trade and revenues dependencies. If international trade is to be pursued, the focus should be on exporting hydrogen-derived products with added value, such as slag or steel or developing sustainable industrial strategies for local use, in order to increase the socio-economic benefits for exporting countries and local communities.

It is worth noting that the majority of announced electrolytic hydrogen projects by 2030 comes from Europe (30%), Australia (20%), Latin America (around 20%, mainly from Chile, but also Brazil and Argentina) and India. Projects in Africa represent less than 10% of announced projects. China is also massively expanding its electrolyzer production. Announced projects for fossil fuel based hydrogen with CCUS comes almost exclusively from the US, Canada and Europe (UK, Norway, Netherlands)[16].

It is imperative not to prioritise the deployment of renewable energy for hydrogen production and export at the expense of decarbonizing the domestic power and industry sector, ensuring access to energy for all and fighting energy poverty.

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13 Does the Green Hydrogen Economy Have a Water Problem? - Versogen
14 https://www.boell.de/en/2022/11/10/green-hydrogen-key-ressource-criteria-sustainable-trade-production
15 https://www.irena.org/publications/2022/Jul/Global-Hydrogen-Trade-Outlook
16 IEA Global Hydrogen Review 2023, p. 66. See also map of low-emission hydrogen production projects: https://www.iea.org/reports/global-hydrogen-review-2023/executive-summary