SEEING GREEN

Hydropower to "Green" Hydrogen is the latest false climate solution

The hydropower lobby and international investors are attempting to market hydropower as a key component of a climate-friendly green hydrogen revolution. While there is merit in decarbonizing hydrogen production by utilizing renewables like wind and solar, investors are seeking massive government subsidies to develop a market for hydrogen produced from large hydropower dams. Not only is hydro-to-hydrogen not clean or "green" - these hydro-to-hydrogen schemes are based on exporting energy to foreign markets and bailing out existing dirty industries, when what we really need is to invest in and support local energy access and a sustainable and just energy transformation.

Aerial photo showing Congo River and the surrounding swamforest in area between Mbandaka and Kinshasa | Photo: Greenpeace/Philip Reynaers

Introduction

In the push to fight climate change and decarbonize the economy, governments and investors around the world are looking to green hydrogen – hydrogen produced with renewable energy – as a key player in the transition from fossil fuels. While there is a clear imperative to shift away from extremely carbon-intensive methods of producing hydrogen, corporations and investors are promoting hydrogen made from hydropower (hydro-to-hydrogen) as key to a new trillion dollar market in green products, and they are seeking billions of dollars in government subsidies and incentives to finance it. This is concerning not only because hydrogen produced with hydropower is not "zero carbon" as hydro-to-hydrogen promoters claim, but it would entail significant irreversible social and environmental impacts from biodiversity loss to displacement and impoverishment of people and communities. Rather than moving the world closer to a just energy transition and climate sustainability, the push for hydro-to-hydrogen could extend a lifeline to disastrous mega-dam projects such as the Democratic Republic of Congo's (DRC's) Grand Inga dam, while diverting resources away from proven solutions for local energy access and climate sustainability.

An aerial view of the semi-functional Inga Dam on the Congo River | Photo by International Rivers

What's all the hype about "green hydrogen"?

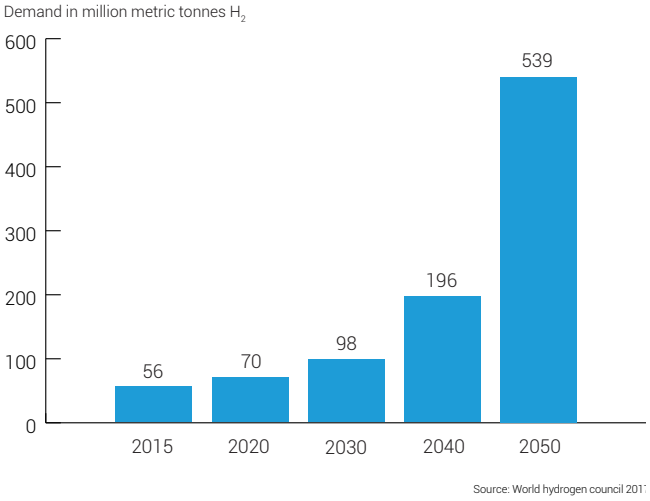
Governments around the world are adopting national plans and strategies to scale up hydrogen development as a means of reducing their fossil fuel consumption. The Hydrogen Council reports that over 30 countries have adopted hydrogen roadmaps, and governments worldwide have pledged more than $70 billion in public funding for hydrogen development. It also estimates that total planned investments for hydrogen projects could reach more than $300 billion through 2030.[1]

The International Renewable Energy Agency (IRENA) estimates that hydrogen could supply up to 12% of overall global energy demand by 2050,[2] while the Hydrogen Council estimates that hydrogen could meet up to 18% of global energy demand, potentially creating a $2.5 trillion a year industry.[3]

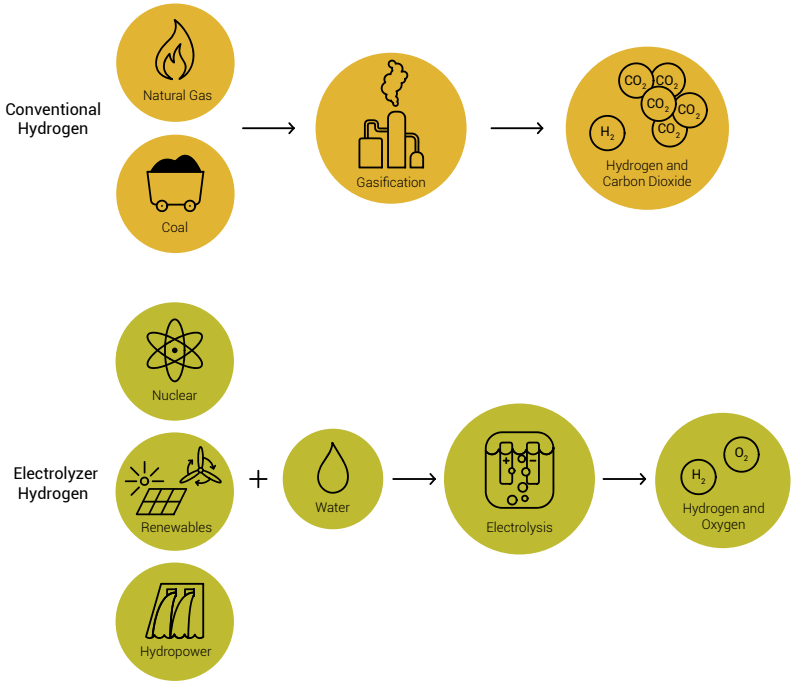
However, a major challenge to the ambitious plans for hydrogen to displace fossil fuels is that the hydrogen utilized today is extremely carbon-intensive. Ninety-six percent of it is produced utilizing a thermal process that relies on fossil fuels[4] (such as coal and natural gas) and produces substantial carbon emissions that are even greater than burning coal.

Hydrogen can alternatively be produced using a process of electrolysis wherein electricity is reacted with water, leaving a byproduct of only oxygen. Yet only 4% of hydrogen produced today utilizes electrolysis, largely because the process is extremely energy-intensive and much more expensive than hydrogen produced through thermal processes.

The hydrogen industry projects a 10-fold increase in hydrogen demand by 2050



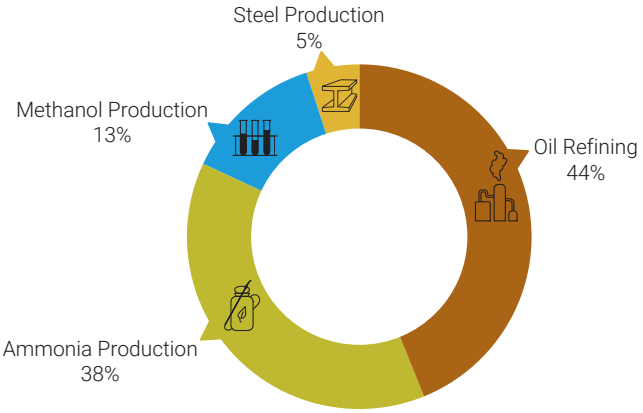
Conventional hydrogen production versus Electrolyzer hydrogen



1 Hydrogen Insights 2021, The Hydrogen Council
2 World Energy Transitions Outlook 2021, IRENA
3 Hydrogen, Scaling Up, Hydrogen Council, 2017
4 New Hydrogen Economy: Hope or Hype?, World Energy Council, 2019

More recently, the promise of "green hydrogen" has captured the attention of industry lobbyists, investors and governments. Because it relies on renewable energy, such as wind, solar, biomass, geothermal or hydropower, to fuel electrolysis, proponents characterize it as having a "zero carbon footprint."[5] There is growing interest in utilizing green hydrogen for power and transport, as well as to replace fossil fuels in the manufacturing of fertilizer, iron, steel and cement, and other chemical processes.[6] However, some investors like Fortescue Future Industries (FFI) are promoting green hydrogen as a panacea for addressing climate change, predicting that it, together with green energy, is destined to be "the world's largest industry." They are demanding enormous government subsidies and incentives to build a market and industry for what they describe as a "miracle" atom.

Virtually all hydrogen produced today is used in industrial processes

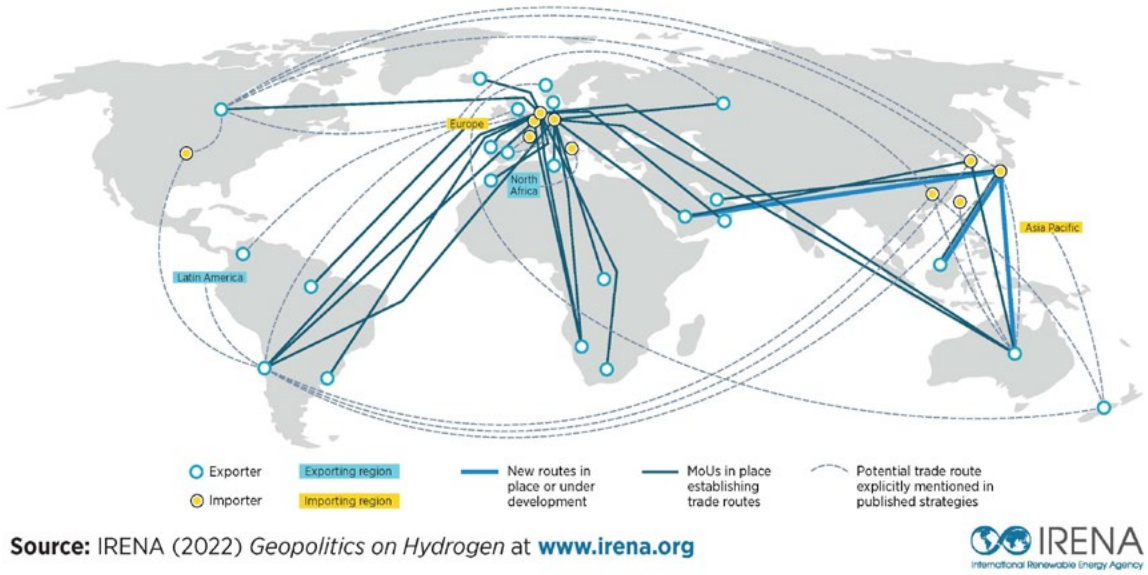


Hopes for green hydrogen are misplaced

While the aspirations for green hydrogen run high, there are significant barriers to it being utilized on a large scale. Green hydrogen as a technology is still in its infancy and hasn't yet been tested at an industrial scale. Although costs have decreased with technological advances, green hydrogen production is still significantly more expensive than hydrogen produced using coal or natural gas. While proponents argue that green hydrogen's ability to be stored will allow a more stable supply of renewables to the grid,[7] converting renewable energy into electricity to produce hydrogen is significantly more inefficient and consequently more expensive than simply consuming electricity from its source. It would also be among the most expensive energy storage options available in most electricity grids, and hydrogen is notoriously difficult and expensive to store and transport.

Scaling up green hydrogen production for widespread use would require major incentives and investments both to further decrease the costs of renewables, as well as to expand the infrastructure needed for hydrogen production, transport, storage and use. This includes developing sufficient electrolyzer capacity, transforming port infrastructure, repurposing existing gas pipelines or constructing dedicated new pipelines, building new rail containers and ships and port facilities, and creating safe storage capacity.

An expanding network of hydrogen trade routes, plans and agreements



Source: IRENA (2022) *Geopolitics on Hydrogen* at **www.irena.org**

IRENA
International Renewable Energy Agency

Hydrogen will primarily be exported from the Global South to demand centers in Europe, East Asia, and the United States.

5 Green Hydrogen, Fortescue Future Industries

6 The green hydrogen revolution: hydropower's transformative role, International Hydropower Association, April 2021

7 Dewa Green Hydrogen Whitepaper, Siemens

A woman holds a fish at a ferry boat harbour on the Congo river | Photo: Thomas Einberger /argum/Greenpeace

Moreover, for green hydrogen promoters like FFI, the future of green hydrogen is based on developing industrial hubs where green hydrogen is used not to produce energy for local populations, but to fuel industrial processes from metals smelting to fertilizer production, primarily through export to foreign demand centers. There is clearly a need and climate benefit to replacing carbon-intense hydrogen with solar- or wind-generated green hydrogen for hard-to-abate sectors. However, the attraction of green hydrogen to the industrial sector appears to stem from the false premise that green hydrogen will allow it to maintain its current, unsustainable levels of production rather than radically adjust their operations to the new climate reality.

The devil in the details: hydro-to-hydrogen

Perhaps the greatest danger of the hype around green hydrogen is that it is being used to promote a return to large-scale hydropower after a period of prolonged decline. While green hydrogen may be produced from any number of renewable energy sources, corporations and industry lobby groups like the International Hydropower Association (IHA) are working to position hydropower as a key fuel source for green hydrogen production. While the hydropower industry has seen a slowing of new capacity in recent years, industry lobbyists are promoting hydro-to-hydrogen as a way to rebrand hydropower and to generate demand for new hydropower plants around the world.[8] Groups like the IHA are lobbying governments to adopt policy reforms and financial incentives for green hydrogen produced with hydropower, while investors like FFI are funneling money into hydropower developments to create a network of green hydrogen exporters and energy hubs.[9]

8 The green hydrogen revolution: hydropower's transformative role, International Hydropower Association, April 2021

9 Energy leaders say governments urgently need to incentivise hydropower, International Hydropower Association, February 2021

Seeing a different "green" in hydrogen

Australian billionaire and mining mogul, Andrew Forrest, has recently rebranded himself as a climate crusader and a leading proponent of green hydrogen and hydro-to-hydrogen. His fossil fuel-intensive mining company, Fortescue Metals Group (FMG), is finding new life and chasing the green market with the creation of Fortescue Future Industries, which will focus on large-scale hydropower and other energy sources to produce green hydrogen and derivative products.[10] Investors like FFI are planning on cashing in on the market for electrolyzer capacity and developing a series of high-intensity energy hubs from Jordan to Brazil wherein green hydrogen production is linked to other "green" products, including ammonia manufacturing, steel production, and export. In addition to the Grand Inga Dam in DRC, FFI is looking at developing up to seven hydropower projects in Papua New Guinea as well as exploiting Indonesian hydropower.

The drainage basin of the Congo River | Image: Wikipedia

Extending a lifeline to the disastrous Grand Inga Dam

In the Democratic Republic of Congo, prospectors have been exploring options to harness the power of the mighty Inga Falls on the Congo River for decades. Now, Fortescue Future Industries (FFI), a subsidiary of Fortescue Metals Group, is intent on developing the Inga site to its maximum stated potential of 40 GW - doubling the size of the largest hydropower project in the world - for the express purpose of producing green hydrogen. Even before FFI came on the scene, plans for a new dam at the Inga site have faced strong opposition from Congolese civil society. Construction of the Inga I and Inga II dams in the 1970s and 80s forcibly evicted thousands of people, depriving communities of their lands and livelihoods, and leaving them deeply impoverished to this day. Investors like the World Bank and Spanish company ACS abandoned plans to develop the Inga site due to governance concerns, high costs and lack of feasibility, and the project has been stalled for years. However, in June 2021, the DRC government awarded FFI the rights to develop on the Inga site. Advocates have raised concerns over the awarding of the contract without a procurement process, in addition to the fact that developing the Inga site would displace tens of thousands more people and threaten a critical carbon sink in the Congo Plume. They also object to the fact that Inga would do nothing to serve the 90% of Congolese who lack electricity: According to FFI's plans, the electricity produced would be used to produce green hydrogen and fertilizers that would be exported to European markets.[11]

Power lines by the Congo River | Photo: International Rivers

10 FFI Profile on IHA website Association, April 2021

11 Fortescue Metals Group's Plan to Develop Grand Inga Hydro Scheme Won't Deliver Green Energy for DRC, International Rivers, June 2021

Why hydro-to-hydrogen is a false climate solution

While green hydrogen could indeed play a role in the energy transition, there are compelling reasons to be skeptical of arguments that green hydrogen and hydro-to-hydrogen are the panacea for climate change that some are claiming.

Hydroelectric dams emit greenhouse gases and are especially vulnerable to climate change.

Healthy rivers draw 200 million tons of carbon out of the atmosphere each year as they transport sediment inland out to the oceans,[12] a function which is disrupted by hydropower dams. Hydropower reservoirs are also a significant source of methane emissions, a gas that is 84 times more greenhouse gas intensive in the near term than carbon dioxide. At their peak of methane production, during the first 10-20 years after construction, the greenhouse gas emissions from hydropower reservoirs can be comparable with that of a fossil fuel-powered power plant.[13] Hydropower dams are also particularly vulnerable to climate change and its weather extremes. More prevalent droughts have caused hydropower dams to run idle, causing hydropower dependent countries and regions to experience prolonged power outages and economic disruptions.

Hydro-to-hydrogen risks more harmful social impacts on local communities.

While green hydrogen can be produced at small scale, the scenarios promoted by hydro-to-hydrogen proponents rely on large hydropower, especially megadams, which comes with serious adverse social and environmental impacts. An estimated 80 million people have been displaced by the construction of dams, losing their homes, livelihoods, and cultures.[14] Indigenous Peoples have been particularly impacted by dam construction. An additional 472 million people have been adversely impacted downstream of dams.[15]

Hydro-to-hydrogen threatens greater loss of biodiversity and ecosystem services.

The construction of large dams also means destruction of some of the most biodiverse river ecosystems, greater water and air pollution, and the loss of critical fisheries and soil replenishment, which provides food security for millions. Freshwater ecosystems are the most degraded in the world with a species average decline of 84% since 1970 and dams and their associated infrastructure being a major culprit.[16] The destruction of river ecosystems also brings with it loss of access to cultural sites and resources essential to Indigenous Peoples and riverine communities.

Virtually all hydrogen produced today is used in industry, including steel production. Photo of blast furnace smelting liquid steel in steel mills | Photo by ABCDstock

12 Global carbon export from the terrestrial biosphere controlled by erosion, Galy et al, Nature, 2015

13 Long considered a "clean" energy source, hydropower can actually be bad for climate, EDF, 2019

14 World Commission on Dams, 2000

15 Lost in Development: The Downstream Human Consequences of Dams, Richter et al, 2010

16 World Wide Fund for Nature, 2020

Hydro-to-hydrogen would require vast subsidies for other otherwise unviable dam projects.

Megadam projects have been shown to be economically unviable in nearly all cases given the steep technical and social and environmental costs involved.[17] Hydropower proponents are banking on significant government incentives for green hydrogen or direct subsidies to hydropower projects to provide momentum and revenue to dam projects that would otherwise not be economically attractive or viable.[18] However, government subsidies would be much more effectively spent in other ways, such as improving the efficiency of energy systems and funding more affordable and faster-to-market sustainable energy options.

The hydro-to-hydrogen hype diverts resources away from energy access and a sustainable and just energy transformation.

Hydro-to-hydrogen schemes involve major investment and development of large centralized capital-intensive energy systems and infrastructure. This means diverting resources which could otherwise be put toward solutions that provide energy access and climate justice[19] for people, such as community-based microhydro and decentralized solar and wind. In fact, FFI's hydro-to-hydrogen development model is not designed to provide energy access, but rather to fuel extractive and dirty industries such as metals and fertilizers. Moreover the hydro-to-hydrogen model is based on exporting local energy resources to foreign markets, often from the Global South to the North, rather than servicing local or national populations.

Hydro-to-hydrogen and wide-scale use of green hydrogen are inefficient, impractical and risky.

FFI and other investors are promoting the development of new large hydro-to-hydrogen complexes, despite construction costs for hydropower being two-to-three times higher than that of solar and wind.[20] And while green hydrogen may provide an effective solution for areas of the economy that are difficult to shift directly to renewables, such as heavy industry, much of the vision of a green hydrogen future is based on green hydrogen going from a nascent technology to becoming a replacement for fossil fuels across the global economy - in residential, transport, and industrial use. Yet in nearly all cases, utilizing hydrogen produced from renewable energy is considerably less efficient than utilizing renewables directly. For instance, using renewable energy to produce electricity, utilizing that electricity to produce hydrogen, storing that hydrogen in a fuel cell, and then using it to heat a home is five-to-six times more inefficient than using renewable energy directly.[21]

The Congo plume is a globally significant carbon sink | NASA

Similarly, using hydrogen fuel cells in vehicles is estimated to be three times more inefficient than using electricity to charge electric vehicles.[22]

Green hydrogen infrastructure expansion would mean additional social and environmental costs.

Green hydrogen produced at scale would require extensive expansion of infrastructure, including electrolyzer facilities, pipeline networks, tankers for road and sea transport, and port facilities. While in some cases existing fossil fuel infrastructure could be repurposed, the additional expansion of infrastructure necessary for wide-scale use of green hydrogen carries potential displacement of communities, pollution, and environmental degradation. It additionally raises significant safety concerns given hydrogen's extreme combustibility. The proposed storage of hydrogen in gas fields or underground salt caverns could pose additional adverse social and environmental impacts.

The green hydrogen hype is unrealistic.

Moreover, even with a significant ramping up in coming decades, there is not enough renewable electricity capacity to produce the hydrogen at the scale some are forecasting. The International Energy Agency's (IEA's) scenario for net zero emissions by 2050 predicts that to meet the hydrogen production envisioned would require "a huge increase" in the use of electricity - a scenario virtually impossible without the use of hydrogen produced from fossil fuels. The projection for so-called merchant hydrogen (hydrogen produced for sale rather than direct consumption) alone **would require more electricity than the current total annual demand of China and the United States combined**.[23]

17 Ending the Flood of Megadams by Flyvbjerg and Ansar, The Wall Street Journal. March 18, 2014

18 As noted by FFI, "Many hydropower resources which were previously uneconomic are now being re-evaluated for hydrogen production, which is the demand centre that has been missing."

19 Climate Justice, International Rivers, www.internationalrivers.org/issues/climate-justice/

20 Hydropower Special Market Report, IEA, 2020

21 Global Hydrogen Review, 2021

22 Hydrogen technology is unlikely to play a major role in sustainable road transport by Patrick Plötz, Nature, 2022

23 IEA Net Zero by 2050, 2021

Conclusion

The transition away from polluting forms of hydrogen production to cleaner forms of hydrogen is welcome. But as with almost any modern technology, green hydrogen can be produced and utilized sustainably or unsustainably. The hydro-to-hydrogen schemes being pushed by investors like FFI ignore both the negative climate impacts as well as the devastating social and environmental impacts of large hydropower. Based on an extractive model, green hydrogen production appears designed more for the purpose of bolstering the profits of outdated and flagging industries than for addressing the critical need for local energy access or sustainable and just energy transformation. Before governments commit public resources to the promotion and development of green hydrogen or any other proposed climate technology, the full range of social and environmental impacts must be examined. When that is done, it becomes clear that any green hydrogen scheme that includes hydro-to-hydrogen is a false climate solution.

Fishing boats along the Congo River | Photo by Roberto Saltori