Green Hydrogen's Impact on Water Supplies

Clean hydrogen has received a lot of interest for its potential use as a tool for decarbonization but has also prompted a lot of concerns. Hydrogen production and use can have serious consequences on water supplies, particularly in areas already facing water scarcity. The production of green hydrogen, as well as certain end uses, can be very water intensive.

Green Hydrogen Production Uses Massive Amounts of Water, Most of which Cannot Be Recycled

- There are two types of water use: water *withdrawals*, where water is taken from a body of water, with some of the water recycled back, and water *consumption*, where water is withdrawn and altered in such a way that it cannot be returned to the original body of water. Hydrogen production requires both types of water use (source).
- Green hydrogen refers to hydrogen produced from water and renewable energy via a process called electrolysis. This process relies on water consumption, because the water molecules involved are broken down in such a way that no water remains once the chemical process is complete.
- In electrolysis, water is split into hydrogen and oxygen molecules using an electric current. This process consumes **2.6 gallons of purified water per kilogram of hydrogen produced**. This is the minimum amount of water required to produce hydrogen. Once electrolysis is complete, the water has been transformed into hydrogen, and **cannot be recycled back into the original water source** (source).
- Electrolysis also requires water that has been purified. Standard freshwater, for example, would not be pure enough for electrolysis due to the presence of trace amounts of minerals and other compounds. Purification requires significantly more "raw" water, or water taken directly from a body of water such as an aquifer, lake, or well. Minerals, chemicals, or other compounds must be filtered out of the water before it can be used. **Depending on the water source, most standard purification processes require roughly double the amount of input water to produce the amount of purified water needed** (source). The reject water from the purification process contains a highly concentrated mix of impurities, making it difficult to reuse.
- This is especially concerning because **55 percent** of green and blue hydrogen production capacity (in operation and planned) in the US is in **medium-to-highly water-stressed regions** (source). Groundwater tables overall are declining more rapidly than in previous decades (source).

Hydrogen Combustion Can Significantly Increase Water Demand

- While green hydrogen production can be extremely water intensive, its water impacts can be compounded depending on how the hydrogen is used.
- The energy sector is the largest water user of all industrial sectors, due in part to cooling requirements at most power plants. In the US, thermal power plants requiring water for cooling accounted for more than **40 percent of all water withdrawals in 2015** (source).
- If hydrogen is **combusted in a power plant**, the cooling requirements of the power plant **will increase**. During one pilot in which a blend of hydrogen and natural gas was combusted in a gas power plant, the plant had to increase

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Concerns about Hydrogen in the Power Sector

Despite the increasing hype surrounding hydrogen in the power sector, there are many reasons to be concerned about its use, including harmful emissions, poor efficiency, storage and transport issues, high water usage, and the potential for explosions.

NO_x EMISSIONS

Burning hydrogen in a power plant can lead to nitrogen oxide (NO_x) emissions at six times the rate of methane. Effective pollution controls for high hydrogen blends and pure H_2 in gas turbines do not yet exist.

DIVERSION OF RENEWABLE ENERGY

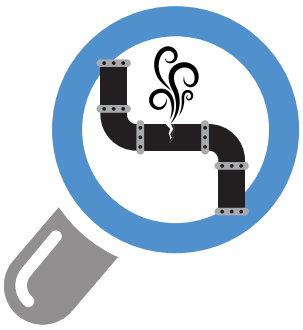
When green hydrogen is burned in a power plant, 70% of the initial renewable energy is wasted due to inefficiencies. This diversion of renewables reduces the amount of fossil fuels that could be directly replaced, along with corresponding reductions in CO_2 emissions.

PUBLIC HEALTH

Burning H_2 would create new sources of local NO_x emissions, harming the health of families in frontline communities for decades to come.

HIGH WATER USAGE

Blue hydrogen and green hydrogen production are extremely water intensive. Blue and green hydrogen plants can use over 3 million gallons of water per day, most of which can't be recycled.



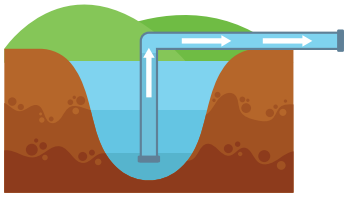
STORAGE AND TRANSPORT

When steel pipelines are exposed to H_2 at high temperatures or high pressure, it can crack the pipes, which could lead to leakage or explosions.

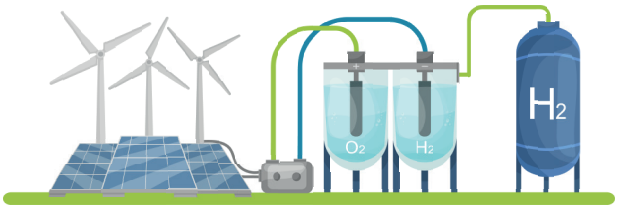
DANGERS OF EXPLOSION

Using H_2 in homes for heating and cooking would lead to four times as many domestic explosions, resulting in increased injuries and loss.

How Much Water Does a **Green Hydrogen Plant** Use in a Year?



Each year, more than
45.1 million gallons of water
are withdrawn from the water supply for purification and cooling.



Each year, more than
26.4 million gallons of water
are consumed—converted to hydrogen or made too impure to reuse—during hydrogen production.
(18.7 million gallons can be recycled and reused)

Each year, that is equivalent to the water use of more than
244 households.

To make green hydrogen, a plant will withdraw water from a nearby water supply such as a municipal water facility or wastewater treatment plant. The water will then be purified and is then run through an electrolyzer, which uses an electric current to break down the water molecules into hydrogen. Any of the water that is broken down into hydrogen molecules cannot be returned to the original water supply and is considered consumed. An average green hydrogen plant producing 11,000 metric tons of hydrogen per year will withdraw over 45.1 million gallons of water a year and will consume 26.4 million gallons of that water.

Source: https://www.energy.gov/sites/default/files/2023-11/1-05-water-consumption-elgowainy.pdf

water injection rates by **20 percent at low levels of hydrogen blending** to maintain air pollutant emissions within regulatory limits. At higher levels of blending, water injections **increased at a linear rate to the amount of hydrogen** (source).

So, Should Clean Hydrogen Be Part of the Clean Energy Transition?

Any role hydrogen fuel plays in the clean energy transition must factor in hydrogen's potential to impact local water supplies, particularly in regions that are experiencing or will experience water stress due to over-extraction and climate change.

This fact sheet only examines green hydrogen concerns related to water. More information about blue hydrogen's water impacts can be found in this companion fact sheet.

All types of clean hydrogen production and use can cause additional harm to nearby communities. While some specific decarbonization use cases may benefit from zero-carbon green hydrogen, these are narrow in scope and should be weighed against the many potential harms associated with hydrogen production and use.

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To learn more about other harms associated with hydrogen's production and use, visit www.cleanegroup.org/initiatives/hydrogen.