Blue and Green Hydrogen Production

POTENTIAL HARMS & GLOBAL WARMING IMPACTS

The hype around using green or blue hydrogen as a decarbonization tool overlooks the fact that all hydrogen use can significantly increase global warming. How hydrogen is produced can have significant climate impacts. The push behind blue and green hydrogen as "clean" alternatives to grey hydrogen, which is produced using fossil fuels, overlooks the fact that **both blue and green hydrogen production can generate even more greenhouse gas emissions than grey hydrogen**.

Blue Hydrogen

Most hydrogen made today is produced using natural gas via a process called steam methane reformation (SMR). SMR is an emissions-intensive process that requires massive amounts of heat. Blue hydrogen is produced through SMR, but with carbon capture and storage (CCS) technology incorporated into the process to capture emissions. This sounds good, except for the negative impacts that often get overlooked.

Potential Harms

- **Energy Intensive:** Producing blue hydrogen requires more energy because the CCS technology must also be powered during the production process. This "energy penalty" means that blue hydrogen requires about 25 percent more natural gas to produce the same volume of hydrogen gas compared to grey hydrogen production (source).
- **Harmful Climate Impacts:** The additional natural gas needed for CCS, coupled with the prolonged use of natural gas infrastructure to produce blue hydrogen, leads to an increase in natural gas leakage and fugitive methane emissions overall.
- **Extends Fossil Fuel Impacts:** CCS technology might capture carbon emissions associated with the SMR process, but it does not capture any of the emissions associated with extracting the natural gas needed to produce blue hydrogen, including the methane leaks that occur during gas drilling, fracking, and transportation through pipelines.
- **Minimal Emissions Reduction:** The emissions and climate impact of producing and burning blue hydrogen is 20 percent greater than burning natural gas or coal for heat. These greenhouse gas emissions are only about 18-25 percent less than producing grey hydrogen (source).

Green Hydrogen

Electrolysis is a process used to create hydrogen from water by using an electric current. Electrolysis can be powered by electricity from any source, including renewable energy, nuclear energy, and fossil fuel energy. If electrolysis is powered using renewable energy to produce green hydrogen, there are no emissions associated with production. But there are other concerns that need to be addressed.

Potential Harms

- **Gross Inefficiencies:** Electrolysis to make hydrogen is incredibly energy intensive. This is because electricity is used to convert water molecules into hydrogen, and then the hydrogen must be re-converted back into electricity, either by running the hydrogen through a fuel cell or by combusting it. Due to energy loss from these conversions, about 60 percent of the energy put into electrolysis is lost (source).

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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.

NOx EMISSIONS

Burning hydrogen in a power plant can lead to nitrogen oxide (NOx) emissions at six times the rate of methane. Effective pollution controls for high hydrogen blends and pure H2 in gas turbines do not yet exist.

DIVERSION OF RENEWABLE ENERGY

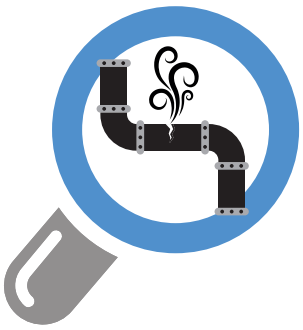
When green hydrogen is burned in a power plant, 70% of the initial renewable energy is wasted due to inefficiencies. This diversion of renewables reduces the amount of fossil fuels that could be directly replaced, along with corresponding reductions in CO_2 emissions.

PUBLIC HEALTH

Burning H2 would create new sources of local NOx emissions, harming the health of families in frontline communities for decades to come.

HIGH WATER USAGE

Electrolysis to create green hydrogen requires up to 9 tons of water per ton of H2 produced. If the water needs to be purified, the amount of water needed could double to 18 tons of water per one ton of hydrogen.



STORAGE AND TRANSPORT

When steel pipelines are exposed to H2 at high temperatures or high pressure, it can crack the pipes, which could lead to leakage or explosions.

DANGERS OF EXPLOSION

Using H2 in homes for heating and cooking would lead to four times as many domestic explosions, resulting in increased injuries and loss.

- **Increased Costs:** Even with federal incentives for hydrogen production, electrolysis is still a very expensive process because it is so energy intensive. To minimize costs, electrolyzers need to be run almost constantly, which can be difficult to achieve with intermittent renewable energy assets like solar and wind (source).
- **Diverts Renewable Energy:** To produce enough green hydrogen to replace all current industrial consumption of grey hydrogen would require 3,500 terra-watt hours of renewable energy, about the same amount of renewable energy currently produced by the entire European Union (source). This renewable energy could be deployed instead to directly decarbonize emissions from the grid.
- **Requires Additionality:** If an electrolyzer is powered by energy from the grid, it causes a massive spike in electricity demand that may not be powered by renewable energy resources. Because of this, electrolysis production powered by even the cleanest grid could have a carbon emissions intensity of roughly double that of hydrogen production using SMR, the dirtiest type of hydrogen production (source).

Are Blue and Green Hydrogen Worth the Hype?

This fact sheet only looks at the global warming potential from the production of blue and green hydrogen. However, both blue and green hydrogen have other harms associated with their use, including impacts on public health and the environment. For example, the impact of hydrogen as a secondary greenhouse case is examined in an accompanying fact sheet on "Hydrogen's Global Warming Impacts." While there may be some decarbonization use cases that could benefit from green hydrogen, these are very narrow in scope and must be weighed against the many harms associated with hydrogen production and use. It would be wise to consider if the hype is worth the potential harm.

Clean Energy Group

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