Iowa Chapter
Physicians for Social Responsibility

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The UK's first Hydrogen fuel station was opened by ITM Power and Shell on 22nd February 2017.
*Source: Wikimedia Commons*

# The "Rainbow Connection" — Hydrogen and Carbon Capture

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This series has been examining concerns, especially health, related to carbon capture. Carbon capture involves a variety of initiatives undertaken purportedly to address looming climate changes. **Our previous report** covered several issues surrounding the plans for three carbon capture and CO2 pipeline projects in Iowa. This report takes an in-depth look at hydrogen and its role in the larger carbon capture debate.

Why does hydrogen matter when scrutinizing carbon capture? Hydrogen is increasingly touted as playing an essential role in decarbonization efforts and meeting national and global "net-zero" goals. Analogous to understanding carbon capture, the issue of hydrogen is complex. It is imperative that we take time to deconstruct industry-led marketing and claims about the promises of hydrogen.

## Background

The National Aeronautics and Space Administration (NASA) began using **liquid hydrogen** in the 1950s as a fuel for rockets. NASA was also one of the first to use hydrogen fuel cells on spacecraft's electrical systems.

Hydrogen is labeled as an "alternative fuel" by the US Department of Energy. Hydrogen was designated as such by the **Energy Policy Act (EPAct) of 1992**. The goals of the EPAct were to reduce U.S. dependence on petroleum and improve air quality by encouraging the use of alternative fuels, renewable energy, and energy efficiency. Hydrogen is considered an alternative fuel, not a renewable fuel.

The **Hydrogen Council** is a trans-national coalition of industry CEOs whose goal is to accelerate the development of hydrogen commerce. Its members include BP, Chevron, Shell, BMW Group, GM, Honda, Cryogenmash (a Russian industrial gas corporation), Enbridge, and several other natural gas companies.

Currently, hydrogen is **used** mainly in petroleum refineries and the production of fertilizer.

## Not All Hydrogen is the Same

Hydrogen is a colorless, odorless gas represented by the symbol $H_2$. Hydrogen does not exist freely in nature and can only be produced from other sources in energy-intensive processes. Hydrogen is typically labeled along a color spectrum. The color label has nothing to do with the actual color of the hydrogen but indicates the method used to produce it and the source for the hydrogen.

Today, most hydrogen is produced via steam methane reforming (SMR). SMR uses heat and pressure to convert the methane in natural gas to hydrogen and $CO_2$. The hydrogen thus produced is referred to as "gray hydrogen." Approximately **seventy-six percent** of global hydrogen production is made by SMR. Twenty-two percent of the hydrogen produced globally is by coal gasification and is labeled "brown hydrogen." **$CO_2$ emissions** from gray and brown hydrogen production are extensive. Each ton of brown hydrogen produced releases nine to twelve tons of $CO_2$ into the atmosphere, which has led to the promotion of "blue hydrogen." Blue hydrogen is produced by capturing the $CO_2$ emissions during methane SMR or coal gasification. **One percent** of the world's hydrogen production is blue hydrogen.

Electrolysis of water yields separate streams of pure hydrogen and oxygen gas. The hydrogen produced by this method is "green" if the electricity required is generated from sources such as wind or solar. Electrolyzing water to separate hydrogen atoms from oxygen is an energy-intensive process. There literally is insufficient **renewable energy** to produce substantial amounts of green hydrogen in most places. Currently, **less than one percent** of the hydrogen produced globally is green hydrogen.

### Table: Colors of Hydrogen

| Hydrogen Color | Process | Source | % of Global Production |
|---|---|---|---|
| Gray | SMR | Methane | 76 % |
| Brown | Gasification | Coal | 22 % |
| Blue | SMR or Gasification + Carbon Capture | Methane or Coal | 1 % |
| Green | Electrolysis Powered by Wind or Solar | Water | 0.4 % |

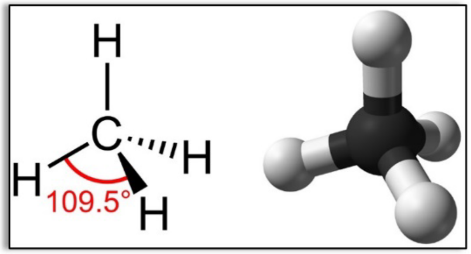
## How Green is Green?

The term "green hydrogen" is used loosely, and sometimes blue hydrogen is referred to as "green". For example, an industry **report** by the **Hydrogen Council** identifies that the use of the term *clean hydrogen*: "in this publication [is] defined as either renewable or low-carbon hydrogen. Renewable hydrogen refers to hydrogen produced from water electrolysis with renewable electricity, while low-carbon hydrogen refers to hydrogen produced from fossil fuel reforming with carbon sequestration."

Blue hydrogen is promoted as a climate-friendly solution. However, recent **research** indicates blue hydrogen's carbon footprint is 20% greater than burning either natural gas or coal directly for heat and 60% greater than using diesel oil for heat.

### Back to Gray Hydrogen – Why be concerned about SMR and natural gas?

We cannot be lulled into complacency by the seemingly benign-sounding name of “natural” gas. Natural gas is a fossil fuel, composed mainly of methane, along with other components such as ethane, propane, butane, carbon dioxide, and water vapor. Methane is a compound consisting of one carbon atom with four hydrogen atoms ($CH_4$).




Model of a methane molecule.
*Source: CNX OpenStax*

Burning of methane releases less $CO_2$ into the atmosphere than burning coal or petroleum, which contributes to the perception that natural gas is an environmentally friendly alternative. However, methane is an extremely potent greenhouse gas, and its use as an energy source is associated with its own set of environmental and health hazards.

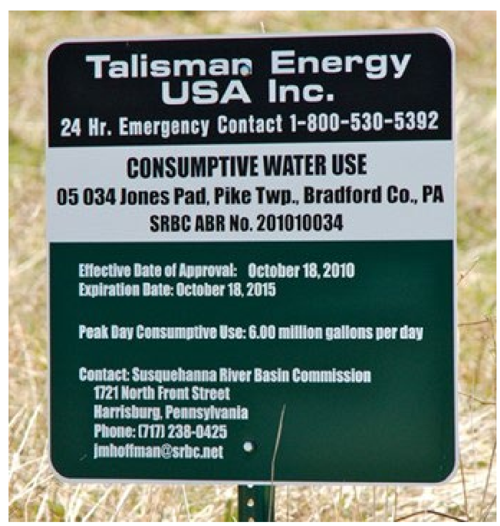
### It's All in the Framing

“Fracking” is a short-hand name for hydraulic fracturing. Hydraulic fracturing, as its name implies, involves injecting water, sand, and chemicals under high pressure into deep rock formations.  The goal is to create new fractures in the rock as well as to increase the size and connectivity of existing fractures.

Hydraulic fracturing involves extensive water use. Much of the natural gas in the US is derived **via fracking**.

In short, the fracturing process releases hazardous amounts of methane, a potent greenhouse gas, much of which escapes into the atmosphere, diverts and pollutes local water supplies, and induces seismic events in the area where fracking is used.

See **here** for a new in-depth discussion on the public health hazards of fracking.




Fracking site in Warren Center, PA
*Source: Wikimedia Commons*

### Energy Earthshot

In July of 2021, the US Department of Energy announced its **Hydrogen Energy Earthshot** initiative.  The program designates $52.5 million to fund 31 projects to advance hydrogen technologies, including the **design** of a commercial-scale advanced carbon capture system from steam methane reforming plants.

## Hydrogen Hubs

The Infrastructure Investment and Jobs Act of 2021 have designated $8 billion for Regional Hydrogen Hubs to expand the use of hydrogen in the industrial sector; $1 billion for a Clean Hydrogen Electrolysis Program to reduce costs of hydrogen produced from clean electricity; and $500 million for Clean Hydrogen Manufacturing and Recycling Initiatives to support equipment manufacturing and domestic supply chains.

Hydrogen hubs are regions where various users of hydrogen across industrial, transport, and energy markets would be co-located. Through the **Regional Hydrogen Hub Program**, the Department of Energy will choose a minimum of four locations in the US to locate hydrogen hubs — networks of hydrogen producers, potential hydrogen consumers, and connective infrastructure, including pipelines. The law calls for varied energy sources for hydrogen production at the hubs, requiring that one hub produce hydrogen from fossil fuels; one from renewables; and one from nuclear energy.

The Department of Energy will solicit proposals until May of 2022 for the hubs with the decisions to be announced in May of 2023.

## Industry Projections

According to the Hydrogen Council's **report** referenced earlier, the industry's plans for growth to the year 2030 are based exclusively on the production of blue hydrogen, and not green hydrogen (pg. 27.) Their projection is built upon policies like the 45Q tax credit set between $50-$100 per ton of CO2. At this price for CO2, the Hydrogen Council projects a 30% conversion from grey to blue hydrogen. So their projections are not only based on the continued production of blue hydrogen, but on receiving tax credits or other subsidies for the accompanying carbon capture, and not on increased market demand for hydrogen.

## Conclusion

The majority of hydrogen fuel produced currently comes from "natural" gas (gray hydrogen). Most natural gas in the US is obtained through fracking. Blue hydrogen is created when the production of gray hydrogen is combined with carbon capture. Carbon capture, as we have seen in our previous reports, is a questionable technology associated with a range of public health hazards. The production of green hydrogen, the singular hydrogen that is legitimately "green", is in its infancy.

Urgent **reports** from the Intergovernmental Panel on Climate Change **(IPCC)** are calling for immediate action. We have existing technologies like wind and solar that have already proven to be scalable. The climate crisis has reached the point of no return. We do not have time to waste funding and resources on experimental and dubious, hypothetical "solutions."

Gray hydrogen combined with carbon capture is not a path to decarbonization.

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**Dear Reader**
The next installment in our series, will examine the opportunity costs of carbon capture.

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