Renewable Natural Gas & Hydrogen

Hydrogen (H_2) is a clean burning and potentially abundant gas with the potential to reshape a number of links in the global energy system as societies move toward net zero. Frustratingly "just around the corner" for decades, hydrogen's potential to decarbonize existing natural gas systems has prompted a surge of interest and investment in the fuel since the mid-2010s.

Itself a strategy for decarbonizing existing natural gas systems, RNG also has an important role to play in the spread of low-emissions hydrogen production.

Energy from Hydrogen

Technically hydrogen is not an energy source, but an *energy carrier.* It is produced using energy and stores that energy, which can then be released through **combustion** of the hydrogen, or its use in **fuel cells**.

- **Combustion:** In the presence of oxygen and an ignition source (a spark), hydrogen releases energy (as heat) and water.[1] This allows it to be used in a similar way to conventional fuels like natural gas.[2]
- **Fuel cells:** A fuel cell is an electrochemical power generator that works very similarly to a battery: a controlled reaction between hydrogen and oxygen within the fuel cell produces energy in the form of electricity. But unlike batteries, fuel cells do not require a charge — they simply need a steady supply of hydrogen and air and produce only water as a by-product.

Hydrogen-powered vehicles can use either internal combustion engines or fuel cells.

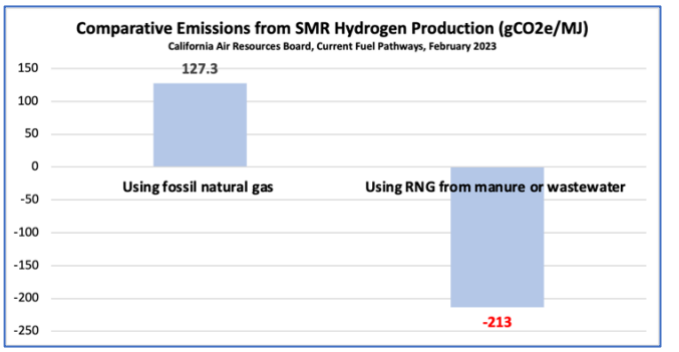
The Problem: Obtaining Hydrogen

Hydrogen is the simplest and most abundant element in the universe. However, pure hydrogen does not occur naturally in large quantities; it is primarily found in other molecules, such as water (H_2O), ammonia (NH_3) and methane (CH_4). This means it must first be disentangled from other constituents.

Production Methods

There are currently two primary methods for producing hydrogen from other compounds:

In **steam methane reforming (SMR)**, methane (CH_4) is exposed to pressurized steam in the presence of a catalyst to separate the hydrogen from the carbon. Carbon monoxide (CO) and carbon dioxide (CO_2) are by-products of this process. Approximately 95% of hydrogen produced in the U.S. is made by SMR, largely with natural gas.[3]

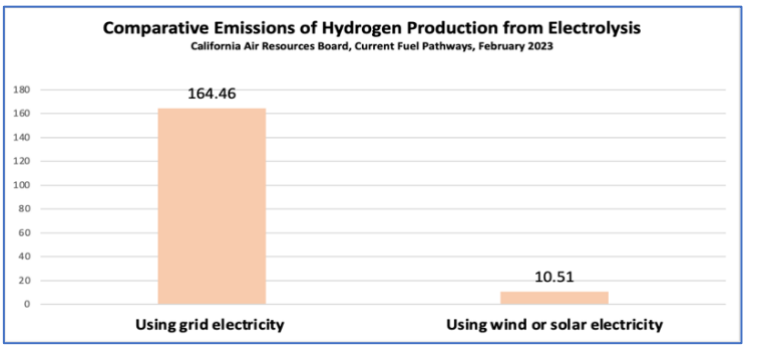


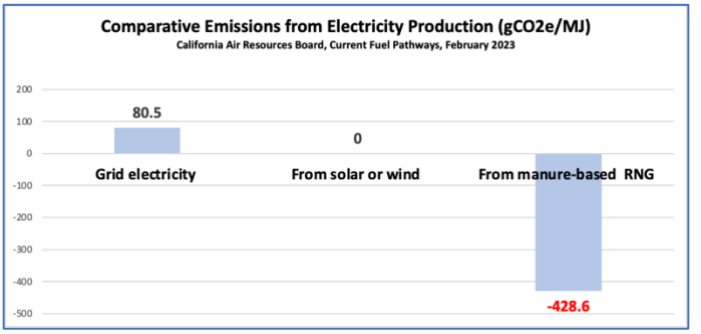
SMR's liability is its energy intensity and potential for GHG emissions from gas combustion. According to the California Air Resources Board (CARB), when assessed on a life-cycle basis hydrogen made from geologic natural gas has a **carbon intensity** (CI) higher than fuels it might replace. However, SMR-generated hydrogen derived from manure-based RNG is *significantly carbon-negative*.[4]

[1] Sciencing, "What Happens When Hydrogen and Oxygen Combine?"
[2] Combustion of hydrogen also releases some nitrogen oxides [NOx], a by-product of heating air. Georgia Tech Strategic Energy Institute, "NOx Emissions from Hydrogen Methane Fuel Blends"; Argonne National Laboratory, GREET modelling tool, EF (Emission Factors) tab. NOx production has dampened the enthusiasm of some environmentalists for hydrogen as an all-purpose fuel.
[3] US Department of Energy, "Hydrogen Production: Natural Gas Reforming."
[4] California Air Resources Board, Current Fuel Pathways table, February 2023.

THE COALITION FOR RENEWABLE NATURAL GAS

In **electrolysis**, an electrical charge is run through water (H_2O) to separate hydrogen and oxygen. When the electricity used to power the process is generated by wind or solar energy, the product hydrogen is carbon neutral. However, hydrogen produced using grid electricity has a CI *even higher* than when produced using SMR with geologic natural gas.[5]





RNG and Low-Carbon Electrolysis

RNG can be used to produce electricity, and therefore can power electrolysis. Although more research is needed on hydrogen produced from RNG-fueled electrolysis, there are promising signs that RNG could contribute to the production of lower-emissions H_2. According to CARB, grid electricity has a carbon intensity of 81.49, while electricity generated using RNG has a CI as low as -700.[6] The use of significantly carbon-negative electricity could potentially produce hydrogen as clean, or cleaner, than hydrogen made with solar or wind-generated electricity.[7]

The US federal government has also acknowledged the promising relationship between RNG and hydrogen. A 2022 draft Production Standard from the US Department of Energy indicates that hydrogen produced from RNG-fueled electrolysis would indeed qualify as "clean hydrogen."[8]

As of 2023, H_2 production at scale using electrolysis remains elusive, due to the high cost of electrolyzers.

Promoting Hydrogen Production

In 2022, the Inflation Reduction Act (IRA) introduced a new hydrogen production tax credit (PTC) that runs for 10 years after a facility begins production.[9] Emphasizing low-emissions production, the "45V" PTC establishes a stair-step credit structure per kilogram of H_2 produced, with the amount of credit increasing as production emissions decline.

EMISSIONS PER KG HYDROGEN PRODUCED				
Low (kgs)	High (kgs)	Maximum Credit	Applicable Percentage of Credit	Total credit/kg H
2.5	≤4	$0.60	20%	$0.12
1.5	<2.5	$0.60	25%	$0.15
0.45	<1.5	$0.60	33.40%	$0.20
0	<.45	$0.60	100%	$0.60

These new incentives are part of a concerted push to unlock hydrogen's potential. Hydrogen has long been considered a "fuel of the future," and we're still not quite there on producing it in quantity. RNG is a low carbon—even carbon-negative—option that is available for decarbonizing gas systems right now. As hydrogen deployment grows, RNG will have a key role to play in the low-emissions production of one of tomorrow's most promising and critical fuels.

[5] Ibid.
[6] Ibid.
[7] Ibid. RNG CI value based on an average of manure-based RNG projects in the Current Pathways.
[8] "U.S. Department of Energy Clean Hydrogen Production Standard (CHPS) Draft Guidance," 2022.
[9] Construction of the facility must begin by December 31, 2032.