SURERUS MURPHY

A JOINT VENTURE COMPANY

A bountiful and clean renewable energy source

Hydrogen is one of the most basic elements on Earth. As a single proton and a single electron, it is abundant and available—usually combined with other elements. When separated from other elements, it produces a clean energy source that is a key component to achieving net zero emissions.

HYDROGEN

Our Services

Surerus Murphy draws from an extensive and worldwide resource pool of Professional Engineers, Project Managers, and Construction Experts, that can build Hydrogen facilities, including:

- Production Facilities
- Pipelines and Compression Facilities
- Pipeline Retrofitting
- Front End Engineering and Design (FEED) for all highlighted construction capabilities

Hydrogen is the smallest and lightest molecule in the Universe. It is 50,000 times smaller than the thickness of a hair and one liter of hydrogen gas weighs 90 mg under normal conditions of pressure and temperature; this weight is equivalent to three postage stamps. It can be produced from a diverse range of domestic resources, including:

- Fossil fuels
- Biomass
- Water

Hydrogen is commonly used as a feedstock for chemical and fertilizer production, but its main purpose is to make fuel cleaner by eliminating the sulfur that is naturally found in crude oil through the hydrocarbon upgrading process. To reduce greenhouse gas emissions over the coming years, Hydrogen is expected to be used in a variety of other applications such as:

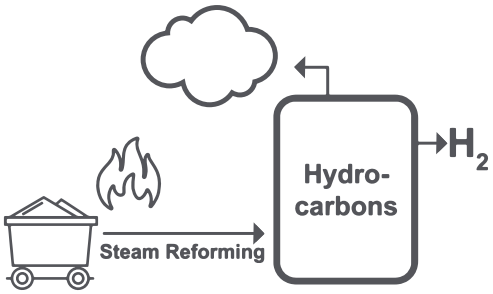
- Hydrogen fuel cells for light duty vehicles, heavy haul trucks, trains, and ships
- Power generation
- Space heating
- Metal refining

Transporting Hydrogen

Hydrogen is transported on the road using liquid tanker trucks or gaseous tube trailers, or by pipeline. Pipelines are deployed in regions with substantial demand (hundreds of tons per day) that is expected to remain stable for decades. Currently, there are studies underway assessing the viability of retrofitting portions of the existing natural gas network to reduce the requirement for building new infrastructure to transport hydrogen. Liquefaction plants, liquid tankers and tube trailers are deployed in regions where demand is emerging or at a smaller scale. Demonstrations of hydrogen delivery via chemical carriers, like ammonia (NH_3), are also underway in large-scale applications, such as export markets.

There is a whole spectrum of colors used when referring to how hydrogen is produced, but we will focus on Grey, Blue, Green and Turquoise.

Grey

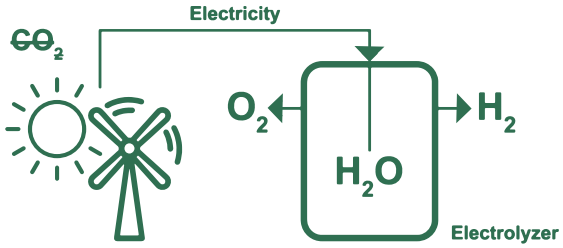


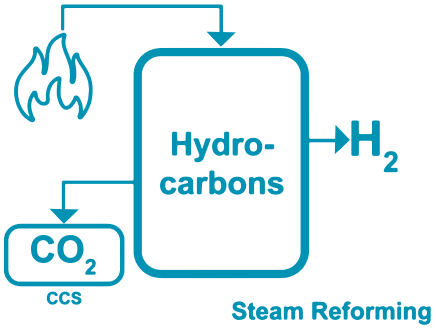
Grey hydrogen is produced using fossil fuels, such as natural gas, via an industrial process called Steam Methane Reforming (SMR) or Autothermal Reforming (ATR). Both processes work to separate the hydrogen from the carbon in the methane molecule (CH4). The main difference between SMR and ATR is that SMR only uses air for combustion as a heat source to create steam, while ATR uses purified oxygen.

In both processes, the byproducts formed are hydrogen as well as carbon dioxide. The hydrogen is captured and used while the carbon dioxide is simply released into the atmosphere. On average, 8-10 tonnes of CO_2 are generated as waste per tonne of hydrogen produced. Hydrogen has been produced this way for decades and while it is the cheapest way of producing hydrogen, it is not the most environmentally friendly.

Green

Green hydrogen is produced by the electrolysis of water, meaning the breakdown of water molecules into the two individual elements—hydrogen and oxygen. Only electricity from a renewable source such as solar, hydro or wind is used, and no CO_2 is produced. This allows the generated hydrogen to be climate neutral. To produce green hydrogen cost effectively, it must be produced at large scale. This requires a large amount of energy from renewable sources. In addition, electricity prices must be also affordable for green hydrogen to compete with the much cheaper blue hydrogen.





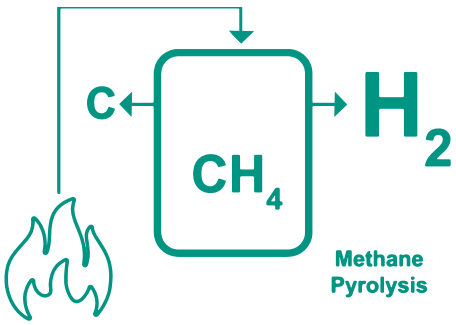
Blue

In blue hydrogen, the same production processes—SMR or ATR—are involved. However, there is an added component of capturing the carbon dioxide before it enters the atmosphere. Current technology has made this process quite efficient so that a significant portion of CO_2 can be captured. Blue hydrogen is going to play an important role in kick starting the energy transition, as it offers the cheapest method of producing hydrogen. This is due to cheap natural gas costs and accounts for an increasing carbon tax by capturing and sequestering the CO_2.

Turquoise

Last, we have turquoise hydrogen which is created when natural gas is broken down via methane pyrolysis into hydrogen and solid carbon. There is no CO_2 generated. Instead, the carbon comes out of the process as a solid. It can then be used in a variety of industrial applications such as rubber, plastics and printer ink.

Pyrolysis is a developing hydrogen production technology which uses high temperature heat to split the methane molecule into its constituent elements resulting in a pure form of hydrogen gas and solid carbon. This technology has been deployed commercially as a source of solid carbon (thermal black) and is now being developed as an economic alternative to SMR for hydrogen production.



FURTHER READINGS

HYDROGEN STRATEGY FOR CANADA

www.nrcan.gc.ca/sites/www.nrcan.gc.ca/files/environment/hydrogen/NRCan_Hydrogen-Strategy-Canada-na-en-v3.pdf

CANADA'S NET ZERO FUTURE

climatechoices.ca/wp-content/uploads/2021/02/Canadas-Net-Zero-Future_FINAL-2.pdf

NET ZERO EMISSIONS BY 2050

www.canada.ca/en/services/environment/weather/climatechange/climate-plan/net-zero-emissions-2050.html

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