A RENEWABLE ENERGY OPTION

HYDROGEN ENERGY

THE ENERGY **FROM HYDROGEN**

WHAT IS HYDROGEN?

HYDROGEN (H) IS THE MOST COMMON ELEMENT IN THE UNIVERSE.

It is the main material in stars and gaseous planets. However, hydrogen is rarely found in pure form on Earth. It is most often combined with other atoms, such as oxygen, in the form of water (H_2O), or carbon, in the form of hydrocarbons (C_xH_y). Hydrogen exists in the following two states:

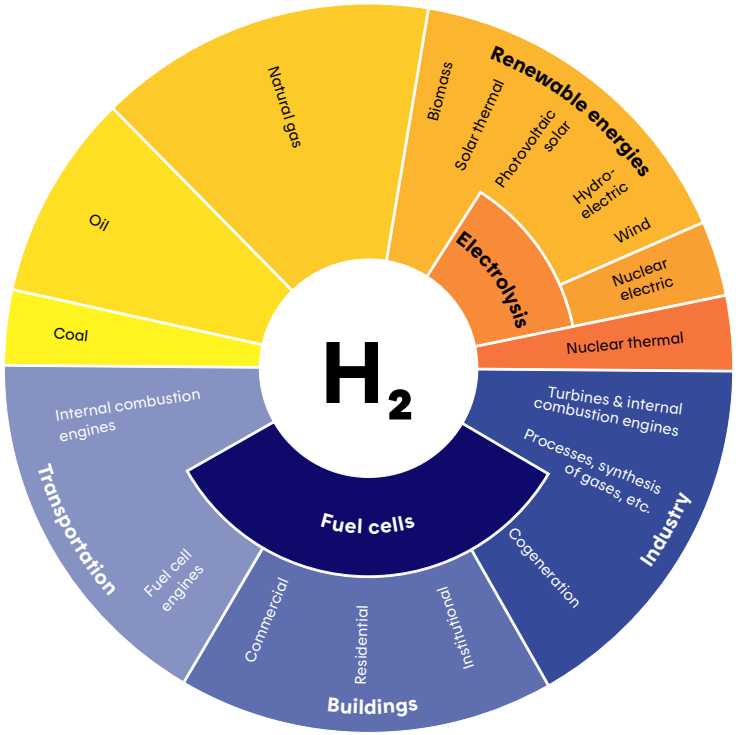
- Gaseous: Two hydrogen atoms are bonded together in a form referred to as "dihydrogen" (H_2).
- Liquid: Hydrogen becomes a liquid at −252.87°C.

To obtain hydrogen, it therefore has to be extracted from the molecules in which it is found. There are several methods for extracting hydrogen, including water electrolysis and steam reforming of natural gas. Producing hydrogen through water electrolysis is attractive from an environmental perspective because it does not release any carbon dioxide (CO_2) and can be done locally.

Hydrogen is not a form of energy. Rather, it is an energy vector, meaning that it can carry energy obtained from a primary source for later use. Hydrogen is one of the solutions to energy storage limitations and the intermittent nature of renewable energy generation.

To date, hydrogen has been used primarily in the chemical and refining industries, but it has other potential applications in areas such as energy storage and transportation fuel.

Production methods



Applications

CURRENT STATE OF KNOWLEDGE

Steam reforming of natural gas is a common method of producing hydrogen. When the atoms in methane (CH_4) are exposed to steam and heat, the atoms separate and rearrange themselves in the form of dihydrogen (H_2) and carbon dioxide (CO_2).

HYDROGEN'S POTENTIAL

Today, hydrogen is almost exclusively used in industrial applications, in chemistry and refining. In the future, it could play an important role in the transportation, natural gas, and heat and power generation industries.

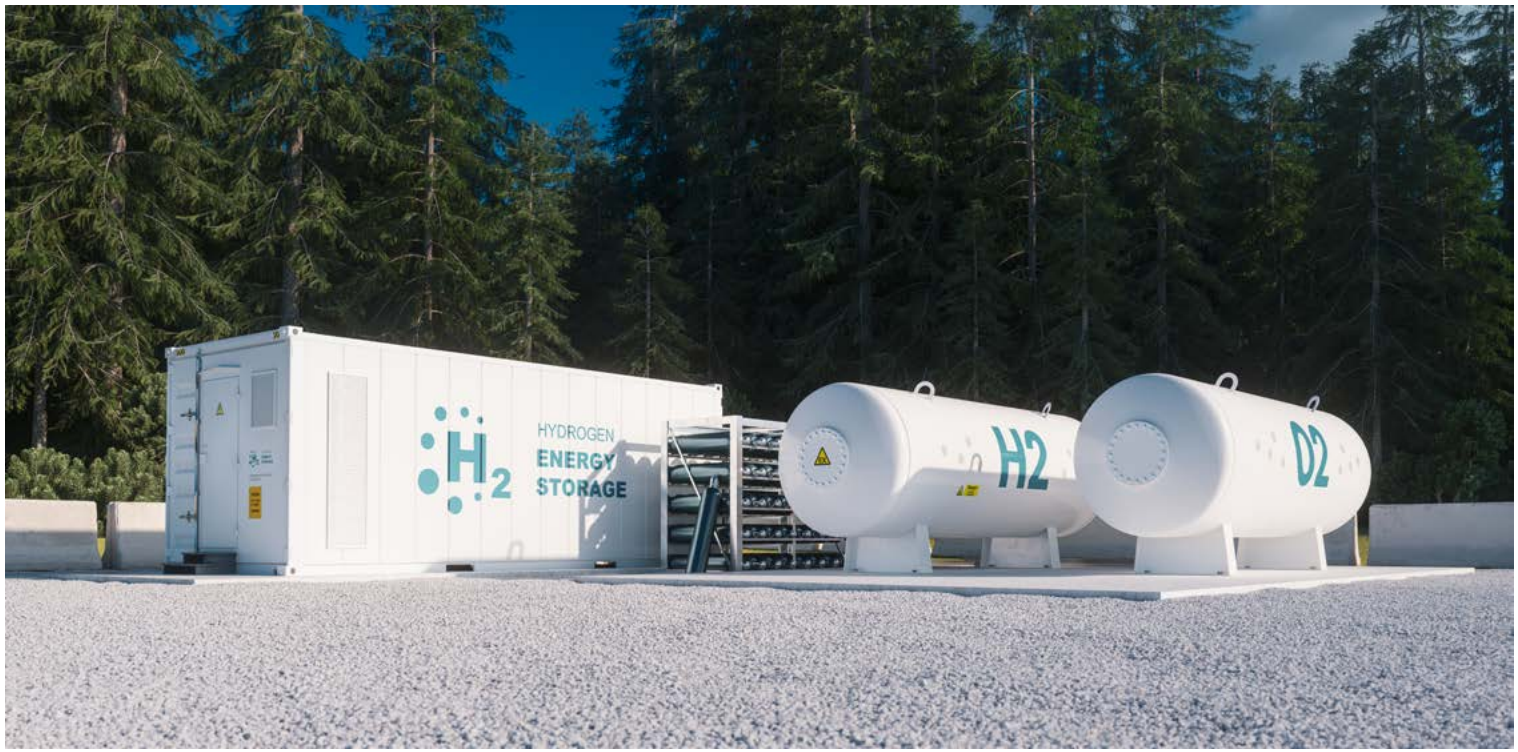
Vehicle charging at a hydrogen charging station.

OUTPUT AND COSTS

Today, 95% of hydrogen is produced from hydrocarbons (oil, coal and natural gas), the lowest-cost method. However, this process emits CO_2, a greenhouse gas. Industrial players are therefore increasingly looking into the possibility of producing hydrogen via electrolysis, using low-carbon energies. However, there is still work to be done in bringing down the associated production costs, which are currently considerably higher than for steam reforming. To achieve that goal, costs across the entire production line have to be significantly reduced, including the price of electrolyzers and fuel cell vehicles.

ADVANTAGES AND DISADVANTAGES

- Non-polluting production if it uses renewable electricity (every other hydrogen production method is polluting)
- No pollutants released by hydrogen combustion, just water
- Ability to produce carbon-neutral fuels (gasoline, fuel oil, kerosene, etc.) by combining hydrogen and carbon chains, such as biomass
- Access to competitively priced low-carbon electricity to reduce the cost of producing hydrogen through electrolysis
- Essential role in decarbonizing transportation
- Hydrogen still more expensive to produce via electrolysis than via natural gas reforming
- Additional costs for certain conversion processes (methanation, Fischer Tropsch), which require CO_2
- CO_2 capture technologies to be developed
- Significant investments required for transportation and distribution infrastructure



Hydrogen storage unit.

SUSTAINABILITY

- No greenhouse gas is emitted during hydrogen use, but some gas may be emitted during its production, depending on the techniques and energy sources used.
- Hydrogen production, storage and distribution infrastructure are nearly non-existent in Québec. This infrastructure can have a considerable impact on the environment if virgin sites are used. Converting existing sites is therefore recommended.
- Platinum, which is used to make fuel cells for hydrogen-powered vehicles, is a rare metal but can be recycled.

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REFERENCE

1. IFP ÉNERGIES NOUVELLES. Undated. All about Hydrogen. (Online). https://www.ifpenergiesnouvelles.com/issues-and-foresight/decoding-keys/renewable-energies/all-about-hydrogen. Page accessed on November 27, 2020.