

IN BRIEF

Hydrogen



The key element of the energy transition

Air Liquide, a pioneer in hydrogen

For more than 50 years, the Group has developed unique expertise across the entire supply chain, from production, to storage and distribution, as well as in the development of applications for end users.

Air Liquide sold 14 billion m³ (1.2 million tons) of hydrogen in 2018, mainly to the refinery and petrochemical industries, generating approximately €2 billion in revenue.

Hydrogen is now becoming a key element of the energy transition, thanks to its numerous uses, like heating and mobility.

2030
Air Liquide aims at delivering hydrogen from renewable or low-carbon energy for mobility applications by 2030

Air Liquide and mobility

More than **120** hydrogen stations

Fuel cells produce electricity with water as the only by-product at point of use.

In 2015, Air Liquide launched **Hype**, the world's first fleet of zero-emission hydrogen-powered taxis. With already more than 100 vehicles, the fleet should reach 600 by the end of 2020.

Air Liquide supplies low-carbon hydrogen for the first hydrogen bus line in France, as well as the Navibus, a riverboat in Nantes.

Thanks to **CertifHy**, Air Liquide can offer its EU customers certified low-carbon hydrogen.

Cryocap™ H₂
A unique solution for the capture and utilization of 100 tons of CO₂ per year (through beverage carbonation, deep-freezing, agriculture).

Hydrogen production

Hydrogen is the most abundant element on Earth: it can be found everywhere but almost always combined with other chemical elements. It should therefore be separated from those elements in order to produce this versatile gas.

It can be produced using different ways:

- Using carbon chains (natural gas, biomass, or coal), with or without CO₂ sequestration
- Through water electrolysis

Electrolysis consists in recovering the hydrogen naturally present in water by placing two electrodes in it. The passage of an electrical current through it breaks down water molecules (H₂O) into hydrogen (H₂) on one side, and oxygen (O₂) on the other.



Air Liquide already has...

and nearly **300** H₂ forklifts in Europe.

40 electrolyzers operating worldwide

Ambitious projects

- **A stake in Cummins-Hydrogenics**, specialised in fuel cells & electrolysis equipment for hydrogen production.
- **A 40% stake in H2V**, aiming to build a large-scale electrolyzer complex (up to 200 MW) for the production of renewable and low-carbon hydrogen in France.
- **HyBalance, an electrolyzer in Denmark** operating with a capacity of 1.2 MW, producing approximately 500 kg of hydrogen per day with no CO₂ emissions.
- Operating the **world's largest Proton Exchange Membrane electrolyzer** (20 MW), in Canada to supply industrial customers with renewable hydrogen.
- **A daily production of 30 tons of renewable liquid hydrogen in Nevada**, north of Las Vegas, mostly from renewable natural gas, by 2022.
- **HyGreen, a cooperation agreement** which aims at producing, storing and distributing several tens of thousands of metric tons of green hydrogen.

Air Liquide is behind several international initiatives: the **Hydrogen Council** (109 of the biggest companies from energy, transport, industry, and finance), **JHyM** (Japan), and **H2 Mobility** (Germany). The Group also fosters many other national and international partnerships.

BÉCANCOUR

Renewable Hydrogen Unit

A unique facility in North America

Commissioned in 1987, Air Liquide Canada's Bécancour facility has since been producing both gaseous and liquid hydrogen to industrial customers across Canada and the U.S.

The world's largest operating Proton Exchange Membrane (PEM) electrolysis unit

The 20 MW PEM electrolysis unit features 4 distinct electrolyzers each equipped with Canadian-based Cummins technology, to produce low-carbon hydrogen from renewable sources.

The commissioning of the new **electrolysis unit increases by 50%** the capacity of Air Liquide's **Bécancour** hydrogen production complex.

- Construction began in 2019
- Built on time and on budget
- Capacity: **+8.2 metric tonnes/day**; enough to fuel over **2,000 cars**, or **16,000 forklifts**, or **275 buses** or **230 large trucks**
- Operations and deliveries started in December 2020

Air Liquide Hydrogen Energy in North America

Bécancour's proximity to the main industrial markets in Canada and the United States will help ensure their supply of low-carbon hydrogen **for industrial use and mobility**.



Building the Bécancour PEM electrolyzers:

- 40,000 hours of actual construction work
- 20,000 hours of engineering, project management, safety reviews and supervision

North Las Vegas, Nevada Renewable Hydrogen Plant

- Construction began early 2020
- Operations and deliveries will start as early as end 2021
- 30 tonnes per day of low carbon liquid hydrogen from renewable natural gas



Hydrogen for Mobility

Air Liquide is a key player in the fast-growing North American hydrogen energy market

- **43** stations in California,
- **48** Fuel cell buses in California
- **+8,900** Fuel cell cars in the U.S.



Reducing carbon intensity

Our goal is to provide our industrial and electronics customers with carbon-free and high purity hydrogen to help them reduce their carbon footprint.

Avoiding the emission of

27,000 tonnes of CO₂

per year compared to the traditional hydrogen production process.

This is the equivalent of

10,000 sedan cars



The **Bécancour site** includes a test pad for the next versions of the electrolyzers under development and thus becomes a satellite of our **Innovation Campus Delaware**.