

GREEN GASES NOTEBOOK 2022




ENGIE

RENEWABLE GASES, AN ESSENTIAL ENERGY SOURCE FOR CARBON NEUTRALITY

As a renewable resource, biomethane is a component of the circular economy. Though it remains marginal in the global energy mix, it is an energy source of the future that is needed, alongside low-carbon hydrogen and synthetic gases, to achieve carbon neutrality.

What are renewable gases?

Biogas

Renewable gas obtained from a natural process: the fermentation of organic matter. The production of biogas makes it possible to recover organic waste from agricultural (manure, residues) or urban (sludge, food waste) environments.

Biomethane

A gas with a very high methane concentration derived from biogas purification and injected into the networks. BioNGV or bioLNG (or liquefied biomethane) are used as clean fuels.

Renewable hydrogen

Hydrogen is a gas that is naturally present in the universe. When produced from renewable resources, hydrogen can provide low-CO₂ electricity and heat, both directly or through fuel cells. As a highly versatile fuel, hydrogen can be transported and stored in liquid or gaseous form.

Synthetic methane

This name covers different types of renewable gases (CH₄):

- renewable gases produced from various organic waste according to different processes, such as pyrogasification (a high-temperature thermochemical process that uses waste to produce a gas that can be injected into existing networks) and hydrothermal gasification (a high-pressure, high-temperature thermochemical process for converting liquid biomass into a synthetic gas).
- gases from methanation processes based on low-carbon hydrogen and carbon.

Low-carbon hydrogen

Hydrogen produced with natural gas using various CO₂ capture technologies, which allow it to be stored or reused

Hydrogen: an accelerator of decarbonization

To achieve a carbon-neutral future, ENGIE relies on a diversified energy mix and, in particular, on an ambitious program **to develop hydrogen production, transport, storage and distribution capacities**. This gas **can be stored in underground saline cavities over long periods**. It can be **injected as a mixture into the gas network, or used in pure form** for a variety of purposes, in particular in industry and the mobility sector, or converted into low-carbon electricity. It contributes to solving the problem of the intermittence of renewable energies.

Another fundamental advantage of hydrogen is the fact that it can be **produced from locally established renewable energies**, thereby promoting the **short energy circuit and local jobs**. Thanks to in-depth knowledge of the regions in which it operates and its ability to intervene in the entire value chain - from the development and financing of hydrogen projects to sales to end customers - ENGIE has major assets to bolster its development.

Hydrogen is therefore the promise of a **new technological, energy and industrial sector**, both locally and globally, with **new jobs** at stake, essential as a contribution to the decarbonization of the energy mix. The governments have understood this: in Europe, more than 10 countries (including France) and the European Commission have published their "National Hydrogen Strategy" road map, with the related promises of funding.



Greening gas across the entire value chain

ENGIE has set itself the objective in France of greening gas to reach **100% renewable gas by 2050**. In particular, the Group is present throughout the **entire biomethane chain**, from the development of industrialization projects to its distribution. In France, ENGIE BioZ initiates, develops, finances, builds and operates units for injecting biomethane into the gas network, with a long-term commitment to the regions. In 2021, it inaugurated three methanization units in Sarthe, Ille-et-Vilaine and Haute-Marne in order to produce biomethane by collecting several types of organic matter in the surrounding area. The energy produced can supply thousands of homes and therefore reduce CO₂ emissions. At the same time, the Group is working to **adapt its networks to inject biomethane**, for instance, through the deployment of a temporary storage solution for biomethane when demand falls or the construction of **back-up stations** on the distribution and transmission networks that make it possible to transport local biomethane surpluses to other regions. At the end of the chain, efficient, low-carbon solutions (such as hybrid heat pumps for heating or high-performance engines for land and sea mobility) **are helping customers green their consumption**.



A strategic partnership for the decarbonization of maritime transport

The CMA CGM Group - a world leader in maritime transport and logistics - and ENGIE have entered into a long-term strategic and industrial cooperation on projects **to produce low-carbon fuels**. The goal is to ensure the **development of a synthetic methane production and distribution chain** that can benefit the maritime transportation sector. An initial project for the production of liquefied biomethane (bioLNG) dedicated to maritime transport has already been initiated at the Marseille Maritime Port Authority, and other industrial projects are in the pipeline. The partnership will facilitate the **pooling of knowledge and R&D efforts**, particularly in key technologies such as carbon capture and green hydrogen production. Today, liquefied natural gas (LNG) reduces sulfur oxide emissions by 99%, fine particle emissions by 91% and nitrogen oxide emissions by 92%.

KEY FIGURES:

1 million
jobs by 2050 in Europe
thanks to renewable energies and
low-carbon hydrogen

27,000
hydrogen charging stations
needed by 2030

ENGIE'S RENEWABLE GAS TARGETS FOR 2030

4 GW
of green hydrogen production
Work was underway in 2021
in the United Arab Emirates.

700 km
of hydrogen dedicated networks
(of which 170 km as from 2025)

1 TWh
of storage capacity
dedicated to hydrogen
(of which 270 GWh as from 2025)
See HyPSTER and HYGreen projects underway

+100
hydrogen charging stations
(of which 50 as from 2025)
Project underway with CERTAS

4 TWh
of biomethane produced
by ENGIE in France
2021 results: 0.33 TWh

40 TWh
of biomethane production
injected into ENGIE's networks in France
2021 results: 6 TWh

Adapting networks

The development of methanization units in France is accompanied by the development of injection points on the network, leading gas distribution and transport networks to adapt their services and methods of operation: taking charge of the operation and maintenance of the injection stations, creating backflows to the transport network in order to unload distribution zones that may be saturated, adapting daily balancing and storage management. Furthermore, the production of hydrogen on an industrial scale requires **the development and planning of future transport and storage networks**. ENGIE is committed to the European H2 Backbone initiative and is supporting the deployment of a network of nearly 40,000 km of hydrogen networks in 21 countries, two-thirds of which would be made up of existing networks that have been repurposed. This vision is already taking shape through the **MosaHYc** pilot project developed in the Moselle region, which aims to **convert two existing gas pipelines** to transport pure hydrogen so as to guarantee a secure supply for mobility use (trains, buses, cars, trucks) and industrial purposes. Other R&D projects currently being deployed, such as **HypSTER** and **Hygreen**, aim to experiment with **hydrogen storage in salt cavities** on sites previously used to store natural gas.

Industrializing the renewable gas solutions of the future

After producing the first cubic meters of green gas from wood in 2020 thanks to the Gaya demonstrator, ENGIE is now **aiming to scale up the pyrogasification process**. With the **Salamandre project**, the Group's objective is to build an industrial biomethane production unit in the port area of Le Havre as early as 2026 in order to gasify nearly 70,000 metric tons of non-recyclable waste per year and produce up to 150 GWh of renewable gas, the equivalent of the consumption of 670 city buses.

The Group is also developing the **MéthyCentre**, a demonstrator aimed at storing electrical energy in the form of renewable gas through hydrogen. Scheduled to be operational by the end of 2022, it will produce 50 kg of green hydrogen per day from renewable electricity – the equivalent of 15 to 20 full tanks of light vehicles – as well as methane gas that will be injected into the local gas network.

Based on the same model, the **HypSTER** demonstrator will be commissioned in 2023 in a region close to the Zero Emission Valley in the Auvergne-Rhône-Alpes region and will be used to test hydrogen production and marketing (for mobility and industry) as well as the storage of hydrogen in saline cavities.

Using new technologies to reduce methane leakage

ENGIE is involved in a European scientific project whose objective is to improve knowledge and the use of new technologies in order to **quantify methane emissions** in networks and thereby **bolster actions to reduce these emissions**. 14 European gas network managers and gas associations are involved in the project coordinated by the European Gas Research Group (GERG) and ENGIE is present via GRTgaz's Research and Innovation Centre (RICE), which has identified the most promising technologies to be tested. In addition to on-site measurements, as close as possible to the equipment, these new remote measurement technologies aim to **quantify the overall emissions of a geographical area and give an overall assessment**. Embedded in drones, moving vehicles on the ground or in the air, or installed on site, **12 different technologies are being tested** to assess their accuracy and reliability. This collective project illustrates the efforts being made by gas operators to significantly reduce methane emissions in order to contribute to **short-term climate change mitigation** and reinforce the environmental value of gas and gas networks in the energy transition.

2021 KEY FIGURES

351

biomethane injection stations operated by the Group's networks in France (147 commissioned in 2021)

95

new Natural Gas Vehicle (NGV) refueling stations connected in 2021 in France, 460 stations installed in total

ENGIE is also developing several initiatives aimed at using hydrogen to decarbonize industry and to develop new industrial sectors:

- **The Yuri project** in Australia involves converting a fertilizer production plant into a green hydrogen production unit. It is scheduled to be commissioned in 2024.
- **The HyNetherlands project** will enable the deployment of an electrolyzer to produce renewable hydrogen for industry and heavy mobility in the Netherlands from 2025.
- **The Masshyla project** aims to develop, build and operate one of the largest renewable hydrogen production sites in France in the South-Provence-Alpes-Côte d'Azur region.
- **The HyEx project** in Chile aims to power an ammonia plant with green hydrogen by 2025.

To further **scale up** low-carbon and renewable hydrogen projects, in 2021 ENGIE announced a partnership with **Equinor**, Norway's leading energy provider, to explore the **development of low-carbon** hydrogen value chains in Belgium, the Netherlands and France.



Drive and support the changes required for the development of renewable gas

Europe and France have set ambitious carbon-neutrality targets for 2050. Considering that an all-electric energy mix would lead to **significant additional costs and would not guarantee security of supply**, especially during peak periods, ENGIE is calling for a more balanced alternative in which the decarbonized or low-carbon (CCS) gas vector will continue to play an essential role. France, for example, has **significant**

biomass potential that can now be put to good use to produce biomethane. This will green a number of uses, including industries that are difficult to electrify. In a circular economy, this local resource will not only **provide secure supply at competitive costs** but also **positive externalities for employment and farming**. In the medium term, synthetic gases and hydrogen will complete this energy mix.



Interview with Edouard Sauvage,

Executive Vice President in charge of Networks activities



What are the main objectives of the Networks GBU in 2022?

Our priority in 2022 will be to ensure the safety of our employees and any third parties working for the Group, as well as the safety of our property, at all Group entities. Our other primary objective will be to guarantee the operational and financial performance of our electricity and gas networks. In France, we are actively preparing the future of our gas networks by developing renewable gas sectors and promoting the key role of gas and gas networks in achieving the energy transition. Lastly, in Brazil, ENGIE will continue the construction of its electric transmission lines.

What were the key achievements of the Networks GBU in 2021?

We should note, first of all, that despite the impacts of the health crisis, we maintained a high level of operational and financial performance in our gas networks, both in France and abroad.

In addition, we continued to prepare the future of our gas networks in France. We took many actions to promote and scale up the biomethane sector. As such, we should applaud the fact that, at the end of December 2021, France had 351 units in production for a capacity of 6.2 TWh, two years ahead of the target set by the PPE. We also helped our customers with ambitious projects, as demonstrated by the signing of a partnership agreement with CMA-CGM to support the decarbonization of maritime transport through the development of synthetic methane and bio-LNG. We pursued our innovation efforts as well, with the inauguration of GRTgaz's R&D platform (FenHYx) and demonstration projects for the conversion of our gas networks to hydrogen (MosaHYc, Hypster, Jupiter 1000, etc.).

Lastly, we continued the construction and commissioning of our 2,800 km of electric transmission lines in Brazil (Gralha Azul and Novo Estado projects).

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