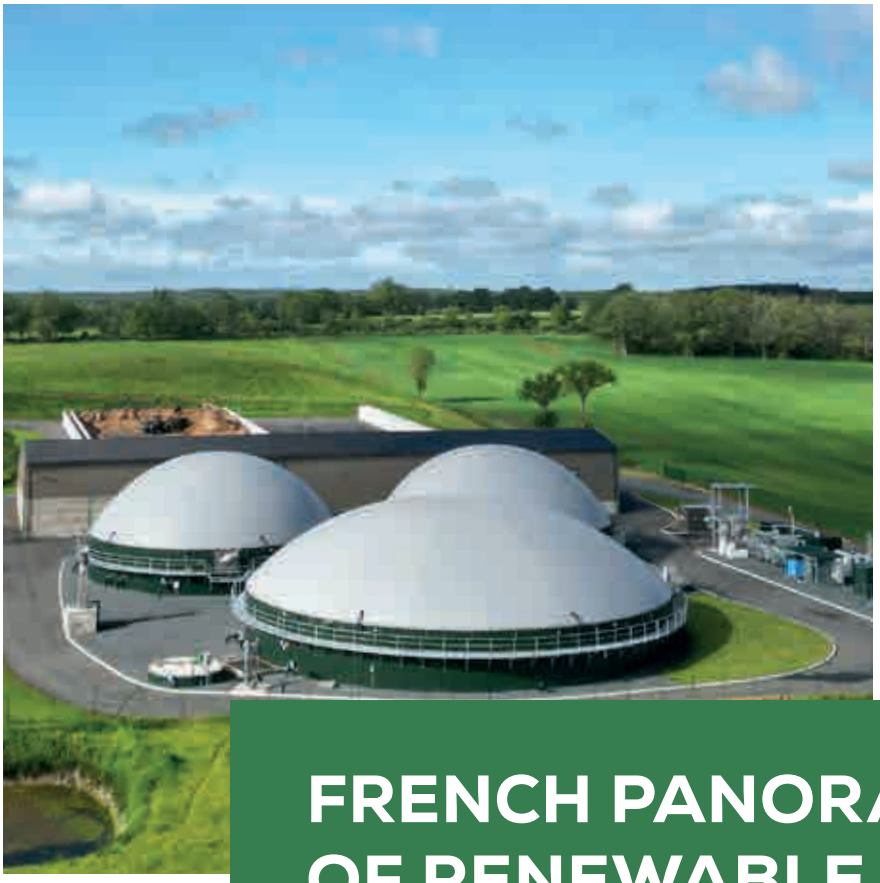


# FRENCH PANORAMA OF RENEWABLE GAS IN 2024

ser Syndicat des énergies renouvelables

Gaz et Territoires
Syndicat des entreprises locales gazières

GRDF

natran

TERĒGA

# FOREWORD

*This 10th edition of our "Panorama of Renewable Gas" provides updated data on the renewable gas industry in France in the form of infographics and is the result of a cooperation between the French Renewable Energy Trade Association (SER), Gas and Territories, GRDF, NaTran and Teréga.*

*The renewable gas sector, which emerged in the early 2010s, has become an established part of the French energy mix. As a result, the quantities of production injected into the gas networks have further increased in a year, reaching 11.6 TWh[1] at the end of 2024, compared with 9.1 TWh at the end of 2023 (+27%).*

*All the data in this panorama is set against France's renewable gas production ambitions for the coming years. The overview also includes industry news, the economic and regulatory framework, a section on Europe and a presentation of biomethane injection projects.*

*After a phase of significant growth thanks to investment and the mobilisation of stakeholders, the sector is now experiencing a marked slowdown in commissioning. The 2019 tariff review, exacerbated by health and energy crises, has undermined its development. The lack of visibility and the instability of the economic and regulatory frameworks are hampering its growth. The tariff review of June 2023 has reversed this trend, but there is still an urgent need to create the necessary conditions for a lasting revival of the sector, by giving stakeholders greater visibility and unlocking the potential of new, complementary renewable gas production technologies, such as pyro-gasification, hydrothermal gasification and anaerobic digestion.*

1. 11,609 GWh in 2024 to be precise. A watt-hour (Wh) is a unit of measurement used for the production or consumption of energy.
1 kilowatt-hour (kWh) = 1,000 Wh / 1 megawatt-hour (MWh) = 1,000 kWh / 1 gigawatt-hour (GWh) = 1,000 MWh / 1 terawatt-hour (TWh) = 1,000 GWh

# EDITORIAL

The year 2024 will be marked by a series of political upturns and major challenges for the energy sector. The launch, in early November, of consultations on the National Low-Carbon Strategy (NLCS, or SNBC in French) and the Multiannual Energy Programme (MEP, or PPE in French) is a key moment for setting public priorities for the next decade, and enabling us to achieve carbon neutrality by 2050.

While the industry welcomes the target of 44 TWh GCV of biomethane injected by 2030, it remains cautious about the future role of gas in the French energy mix. The 2030 trajectory seems coherent, but the target set for 2035 – between 44 and 79 TWh GCV – clearly lacks ambition and could be seen as a halting signal capable of slowing the industry's momentum, even though it has significant production potential. This potential can be fully exploited provided that appropriate financial and regulatory support and promotional measures are put in place, such as the launch of communication campaigns and support for the development of uses. In this respect, the MEP does not include targets for the complementary renewable and low-carbon gas production technologies of pyro-gasification, hydrothermal gasification and anaerobic digestion, which are essential to achieving decarbonisation goals. Similarly, the MEP does not include non-injected biomethane, whose potential also deserves to be fully exploited when producers are located far from the gas networks.

Industry stakeholders stress the importance of balanced energy planning that fully and meaningfully integrates the advantages of renewable and low-carbon gases in order to achieve a successful energy transition. They highlight that the development of renewable and low-carbon gas is essential to guaranteeing France's energy sovereignty, promoting the circular economy and the sustainability of French agriculture, and developing local employment while increasing the value of existing gas infrastructures.

## ANAEROBIC DIGESTION: REAFFIRMING ITS KEY ROLE IN THE ENERGY TRANSITION

After two particularly dynamic years, 2024 marked a substantial slowdown in the number of new connections for facilities producing injected biomethane. This slowdown is the result of the revision of feed-in tariffs in 2020, compounded by the successive health and energy crises. With 79 new commissionings in 2024, a level equivalent to 2019, growth in the industry is slowing, and the trend will continue in 2025.

In the future, the biomethane sector must continue to benefit from a public support platform for production, ensuring stability and visibility, particularly for small-scale projects (less than 25 GWh/year). This support must remain consistent with the ambitions of the public authorities. Ambitious targets will also have to be set for schemes that do not rely on public finance and that will support demand for renewable gases: Biogas Production Certificates (BPC) for decarbonisation of the residential/tertiary sector, and the future incentive scheme to reduce the carbon intensity of fuels (IRCIF, or IRICC in French) for mobility. At the same time, it is important that support schemes for consumers of renewable gas for industry are put in place to accelerate the greening of uses.

In July 2024, the publication of the latest regulations relating to the BPC scheme provided a key lever for the development of biomethane. To guarantee its effectiveness, it is essential to set a post-2028 BPC restitution trajectory as soon as possible, in order to provide stability and visibility for players in the sector. Completion of the work on technical implementation will be decisive in ensuring the successful development of biomethane.

Biomethane production will also be boosted by increased demand. This means recognising that the consumption of biomethane reduces the carbon footprint of the purchaser, and creating incentives, particularly tax incentives, to encourage demand.

Furthermore, stakeholders are warning us about the lack of a derogation framework for projects subject to the Zero Net Artificialization (ZNA) law. It is essential to create derogations to guarantee access to the land needed to set up new renewable gas production projects and their infrastructures, while preserving the balance in our territories, in line with the objectives of the RPPSDTE (regional plan for planning, sustainable development and territorial equality, SRADDET in French). At the same time, dialogue with agricultural stakeholders must continue to encourage the emergence of model local facilities serving the collective interest. This involves close collaboration between developers, who provide energy expertise and equity capital, and farmers, who are keen to convert their inputs into organic fertiliser and support the development of their farms as part of the agro-ecological transition.

Finally, at a time when energy, industrial and food sovereignty are strategic priorities for France and Europe, anaerobic digestion has a role to play more than ever.

## COMPLEMENTARY TECHNOLOGIES: SMALL STEPS FORWARD

The MEP project focuses exclusively on anaerobic digestion. At this stage, the project refers to the potential of complementary renewable and low-carbon gas production technologies such as pyro-gasification, hydrothermal gasification and power-to-methane, but without setting any targets for them. However, if a favourable economic framework were rapidly put in place, in particular with clear and appropriate support mechanisms, these technologies could rapidly develop and contribute to the decarbonisation objectives.

Despite its potential and the numerous projects under development in France, pyro-gasification, heralded as a technology of the future, is still awaiting its national call for projects, the initial launch of which was included in the current MEP and scheduled for 2023. This delay is holding back the industrial deployment of a solution that is essential for decarbonising the industrial and heavy transport sectors, while at the same time recovering waste without the slightest atmospheric emissions, given the absence of a chimney.

In 2024, the results of the call for expressions of interest (CEI, or AMI in French) in hydrothermal gasification highlighted strong interest in this technology, which is particularly well suited to the recovery of certain agricultural effluents, sewage sludge and liquid industrial waste. Several pilot projects are expected over the next few years, paving the way for the industrial development of hydrothermal gasification by 2030.

These complementary technologies, which are necessary for the decarbonisation of the gas mix and promising for strengthening energy autonomy, are still in search of better coordination and appropriate prioritisation in public policies. However, the French stakeholders in the sector, made up of major companies, start-ups and cutting-edge research centres, are demonstrating remarkable dynamism, and their development will be underpinned by a clear political signal, which is essential for mobilising the funding needed for their large-scale industrialisation.

The Renewable Gas Panorama partners,

# PRESENTATION OF STAKEHOLDERS

The **French Renewable Energy Trade Association** (SER) has more than 500 members and represents a sector that generates more than 166,000 jobs. SER is the professional organisation that groups together all the renewable energy industry players: wood energy, biofuels, onshore and offshore wind power, marine energy, renewable gas, geothermal energy and heat pumps, hydroelectricity, solar energy and waste-to-energy. SER's mission is to defend the rights and interests of its members and to strengthen the ties that unite them, in particular to develop the renewable energy industry in France and promote the creation of domestic jobs and added value.
www.syndicat-energies-renouvelables.fr

**Gas and Territories** is the trade association representing local gas distribution companies. Its members are local players, belonging to the public or cooperative sphere, with public service and general interest missions at the heart of the territories in which they are established. As closely as possible to what people's expectations are, and thanks to their in-depth local knowledge, local distribution companies support users, create links and local jobs, innovate and speed up the energy transition through their model based on short circuits by generating trust and social acceptance in the areas they serve, home to more than 2 million people.
www.gaz-et-territoires.fr

**GRDF** operates the largest gas distribution network in Europe. It operates and maintains 207,000 km of networks, guaranteeing the safety of people and property. GRDF is the key player in an affordable energy transition that is firmly rooted in local communities. With a presence in more than 9,500 municipalities, the company is a partner to local authorities, helping them to decarbonise through their energy and sustainable mobility policies. GRDF distributes gas to almost 11 million customers for heating, cooking and transport, regardless of their supplier. For each use, GRDF offers pragmatic solutions to reduce its customers' carbon footprint: sobriety, renewable gas, energy efficiency and high-performance equipment. The company is working to achieve 20% renewable gas in the networks by 2030, a target that will enable as many people as possible to benefit from renewable energy produced in France. GRDF is the leading gas distributor to have embarked on a decarbonisation trajectory – all scopes combined and on a like-for-like basis – in line with the Paris Agreement.
www.grdf.fr

**NaTran** is the new name of GRTgaz. The year 2025 marks the 20th anniversary of the company, which is turning a new page in its history by changing its name and adopting a NaTran-2030 corporate project focused on the energy transition and carbon neutrality by 2050. To achieve this, the company is adapting its network and practices to meet ecological, economic and digital challenges. It offers infrastructure and logistics adapted to gases that are part of the energy transition (biomethane, $H_2$ and $CO_2$). NaTran is the 2nd largest gas transmission operator in Europe. The Group has two subsidiaries: Elengy (leader in LNG terminals in Europe) and NaTran Deutschland (operator of the MEGAL network). NaTran carries out public service missions aimed at guaranteeing safe gas transport for its customers. Its NaTran R&I research centre (formerly RICE) is an international benchmark in research and innovation applied to the energy transition. NaTran Groupe key figures: 33,800 km of pipelines, 680 TWh of gas transported, nearly 3,800 employees, €2.6 billion turnover in 2023.
www.natrangroupe.com

Based in the south-west of France, at the crossroads of Europe's major gas flows, **Teréga** has built up exceptional expertise in the development of gas transmission and storage infrastructure over the last 80 years, and today designs innovative solutions to meet the major energy challenges facing France and Europe. A genuine accelerator of the energy transition, Teréga has more than 5,000 km of pipelines and two underground storage facilities representing 15.6% of the French gas transmission network and 26.9% of national storage capacity respectively. The company generated sales of €494 million in 2023 (excluding congestion balancing) and has 646 employees. Corporate social responsibility is at the heart of Teréga's strategy, and the company is committed to the energy transition towards carbon neutrality. Teréga deploys programmes in all areas of ESG (Environment, Social, Governance): the safety of its employees and the security of its infrastructures via the PARI 2025 programme; the sustainable development of territories and social responsibility via the ENERGIZ MOUV programme; the support of philanthropic projects via the "Teréga Accélérateur d'Énergies" endowment fund ; reducing environmental impact through the BE POSITIF programme, with a commitment to reduce greenhouse gas emissions by 34% by 2030 compared with 2021 for all scopes 1, 2 and 3, making it possible to achieve a reduction of 54% for scopes 1 and 2 compared with 2017.
www.terega.fr

# TABLE OF CONTENTS

# 1. BIOMETHANE PRODUCED BY ANAEROBIC DIGESTION: AN ESSENTIAL RENEWABLE GAS

## 1.1. FROM BIOGAS PRODUCTION TO BIOMETHANE INJECTION: A PROMISING SOLUTION TO REDUCE GREENHOUSE GAS EMISSIONS

**Anaerobic digestion** is a mature biogas production process. More specifically, it is a process through which **micro-organisms break down organic animal and/or plant matter**. It produces a gaseous mixture, called **biogas**, that is saturated with water and composed of 50 to 65% methane.

Organic matter comes from various industries: agriculture, industry, catering waste, municipal waste, gas from non-hazardous waste storage facilities[2], etc. Once collected and transported to an anaerobic digestion site, the organic matter is sorted, stirred and heated for several weeks in a digester (oxygen-free vessel). This process produces biogas, which can be recovered as heat only (by combustion in a boiler) or as electricity and heat (by cogeneration). Biogas can also be purified to achieve the quality of natural gas. It is then called "**biomethane**", or "**biomethane fuel - BioNGV**" when used to power vehicles. Regardless of the production process, this purification stage is essential to remove impurities and undesirable components from the biogas, such as carbon dioxide, sulphur compounds and water. Once the biomethane has been purified and odorised, it can be injected into the gas grid.

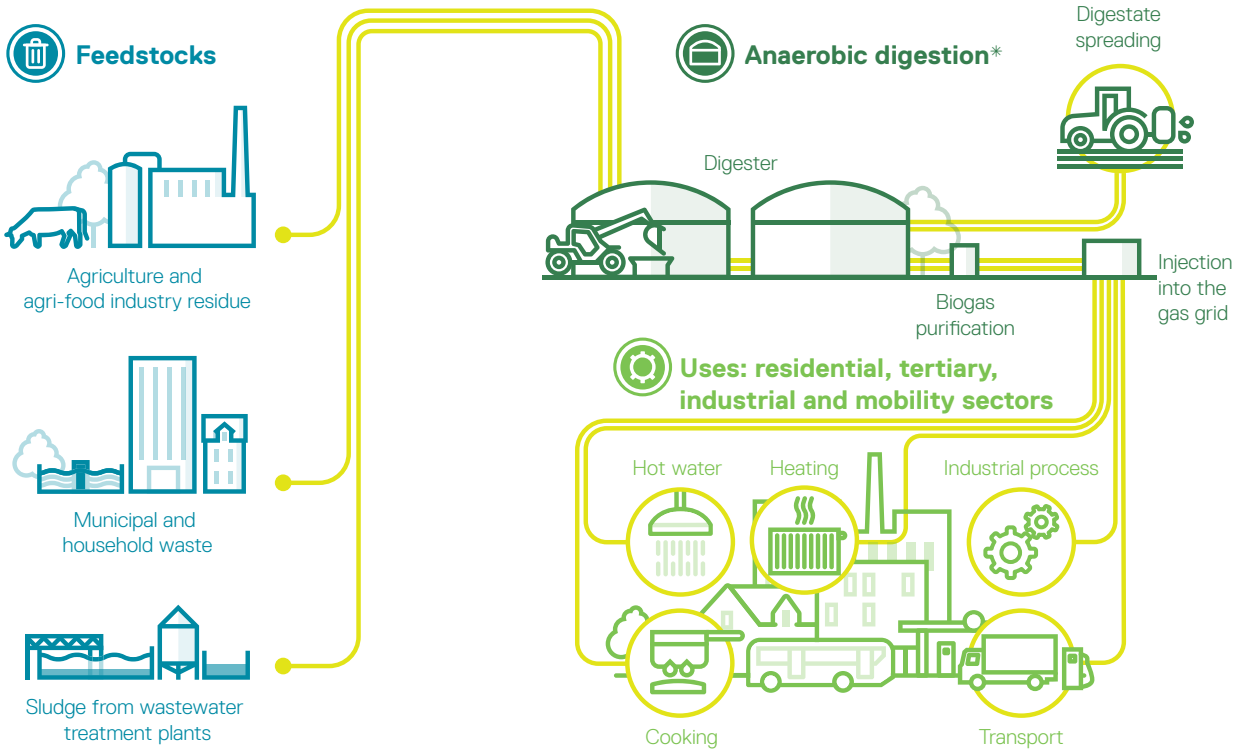
Anaerobic digestion is both a fuel production process and an alternative process for treating organic waste. Collecting this waste to produce biomethane limits its impact on the environment by reducing greenhouse gas (GHG) emissions into the atmosphere and recovering its energy potential. Biogas production also generates a co-product called **digestate**. This is a **natural organic fertiliser** that can be used in farming as a substitute for fossil-based mineral fertilisers.

In light of these benefits, biogas production has been part of France's renewable energy development strategy since 2011. In 2015, the French Energy Transition for Green Growth Act (LTECV) set a minimum production target of 10% of total gas consumption by 2030, which represents 39 to 42 TWh. The Foresight Committee of the Energy Regulation Commission (CRE) concluded that this target was realistic and achievable, and this is also confirmed by the projects currently underway to revise the National Low-Carbon Strategy (NLCS) and the Multiannual Energy Programme (MEP).

2. Gas produced in landfills, mainly from the anaerobic degradation of biodegradable organic matter.

## FROM ANAEROBIC DIGESTION TO INJECTION: KEY STAGES

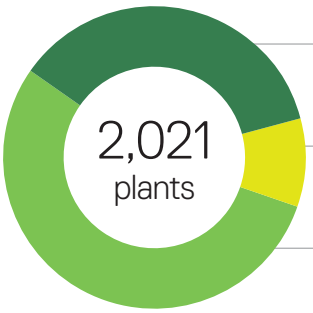
Source: GRDF




* Degradation of fermentable part of feedstocks, without oxygen, to produce biogas.

## NUMBER OF PLANTS PRODUCING AND RECOVERING RENEWABLE GAS AT THE END OF 2024

Source: SER according to ODRe December 2024 & Ministry for Energy Transition dashboard as of 31st of December 2024




- Biomethane injection recovery
  **731 plants · 36%**
  +12% in 2024
- Heat recovery
  **191 plants · 10%**
  -6% in 2024
- Electricity and heat recovery
  **1,099 plantss · 54%**
  +3% en 2024

At the end of 2024, France had a little over 2,000 biogas production facilities, of which 36% convert biogas into biomethane for injection into gas networks, against 14% five years ago.

MéthaFrance
Portail National de la Méthanisation

The "anaerobic digestion portal" project was launched in 2020 and approved by the Ministry of Agriculture and Ecological Transition at the end of 2021. The DGEC (French General Directorate for Energy and Climate) handed SER the reins following a ministerial working group on anaerobic digestion. The digital portal, named "MéthaFrance", was put online in early 2022, at the same time as the national biogas discussion group. The portal, created by a steering committee including a number of industry stakeholder representatives, aims to increase the general public's knowledge and awareness about anaerobic digestion (definition, how it works, challenges, jobs, etc.).

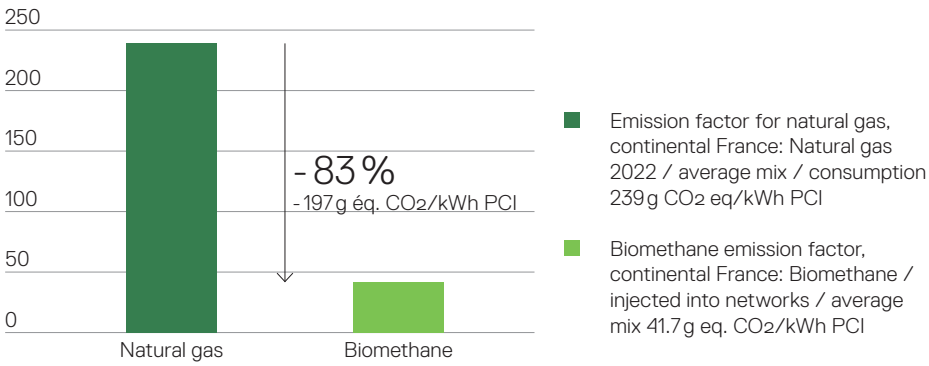
**www.methafrance.fr**

**ADEME's Empreinte database** is an open data tool that makes available **datasets of GHG emission factors for the main energy carriers**. For example, GHG emission factors for natural gas and biomethane are available, based on an LCA (life cycle assessment) approach that takes into account emissions throughout the chain, from production to use.

Example of the substitution of natural gas by biomethane:

### DECARBONATION POTENTIAL OF BIOMETHANE AS A SUBSTITUTE FOR NATURAL GAS

Source/Dataset: ADEME Empreinte® database




**By using 100% biomethane instead of natural gas, the carbon footprint is reduced by 83%, without any modifications to the installation.**

In addition, setting up anaerobic digestion plants is part of a circular economy approach, helping to decarbonise the agricultural sector and preserve local employment/ economic activity.

**https://base-empreinte.ademe.fr/**

BIO MATH anaerobic digestion site. Vallon-en-Sully (03)

# 1.2. TYPES OF BIOMETHANE PRODUCTION FACILITIES AND FEEDSTOCK CATEGORIES

## TYPES OF BIOGAS / BIOMETHANE PRODUCTION PLANTS[3]

There are three categories of production facilities: **(A) anaerobic digestion excl. WWTPs**[4], **(B) WWTP anaerobic digestion**, et **(C) non-hazardous waste storage facilities (ISDND in French)**.


Anaerobic digestion site at Puisieulx (51)
Photo credit: Victorine Alisse / GRDF

### A.1. AUTONOMOUS AGRICULTURAL ANAEROBIC DIGESTION

- Managed by one or more farmers or an agricultural structure
- Anaerobic digestion of more than 90% of agricultural materials from the farm(s)


Bioénergie de la Brie site at Chaumes-en-Brie (77)
Photo credit: Stopandgo / GRDF

### A.2. REGIONAL AGRICULTURAL ANAEROBIC DIGESTION

- Managed by a farmer, a collective of farmers or an agricultural structure
- Anaerobic digestion of more than 50% of materials from the farm(s)
- Including regional waste (industry, WWTP, etc.)


Anaerobic digestion site at Château-Gontier (53)
Photo credit: Franck Dunouau / GRDF

### A.3. REGIONAL ANAEROBIC DIGESTION

- Managed by a project developer or one or more manufacturers
- Anaerobic digestion of materials from farms or elsewhere
- Including regional waste (industry, WWTPs, etc.)


SEMAVERT site at Vert-Le-Grand (91)
Photo credit: Daniel Lheritier / GRDF

### A.4. ANAEROBIC DIGESTION OF HOUSEHOLD WASTE AND BIOWASTE

- Managed by a local authority, waste management union, or one or several manufacturers
- Anaerobic digestion of selectively collected biowaste or factory-sorted organic household waste


Water treatment plant at Bourges Plus (18)
Photo credit: Yannick Pirot / GRDF

### B. ANAEROBIC DIGESTION OF SLUDGE FROM WASTEWATER TREATMENT PLANTS (WWTP)

- Managed by a local authority or manufacturer
- Anaerobic digestion of sludge from the treatment of urban or industrial wastewater


Landfill site at Saint-Palais (18)
Photo credit: Yannick Pirot / GRDF

### C. NON-HAZARDOUS WASTE STORAGE FACILITIES BIOGAS

- The biogas produced naturally in landfills by the decomposition of the organic part of non-hazardous waste is recovered via collection networks

3. MéthaFrance, French national website of anaerobic digestion, "Types of sites": https://www.methafrance.fr/la-methanisation-en-france/les-installations-de-methanisation
4. WWTPs = Wastewater treatment plant (STEP in French).

## OVERVIEW OF THE DIFFERENT TYPES OF ORGANIC MATTER USED TO PRODUCE BIOGAS / BIOMETHANE[5]

Several types of **organic matter**, also referred to as **feedstocks**, can be used to operate a biogas / biomethane production plant.

Crédits photos : GRDF - iStock - AdobeStock

### LIVESTOCK EFFLUENTS

Liquid manure (composed of liquid and solid animal excreta) and manure (mix of liquid manure and animal litter) accounts for the majority of livestock effluents.

### CROP RESIDUES

Crop residues are the above-ground parts of unharvested plants left in fields or orchards after harvesting, such as stems, stalks, leaves or pods.

### INTERMEDIATE ENERGY CROPS / CATCH CROPS

Intermediate energy crops (CIVE in French) are crops that are planted and harvested between two planting seasons in a crop rotation. These crops can be harvested and used as inputs in an agricultural anaerobic digestion plant. Catch crops (CIPAN in French) are temporary fast-growing crops that are used to protect the soil between two main planting seasons. Covers are mandatory in certain regions or areas because of nitrate pollution. These plants use the leftover nitrates from a previous crop to trap them and grow.

### AGRI-FOOD INDUSTRY CO-PRODUCTS

The technological processes used in the agri-food industry to produce end-products (dairy, meat, grains, fruit and vegetables, etc.) generates all kinds of materials. Any material that is recovered and not used in the final product is called a "co-product": e.g., apple pomace, unclassified fruit & vegetables, recipe errors, eggshells, etc.

### ANIMAL BY-PRODUCTS

The European regulation (EC) No. 1069/2009 divides animal by-products into three categories. It defines the manner in which materials from each category must, or can, be removed or recovered for certain uses in order to maintain high levels of hygiene.

### MAIN CROPS / ENERGY CROPS[6]

Crops grown primarily to produce energy. Their use in anaerobic digestion plants is strictly regulated to limit competition between energy and food production.

5. MéthaFrance, French national website of anaerobic digestion, “Organic materials used”: https://www.methafrance.fr/la-methanisation-en-france/les-matieres-organiques
6. These feedstocks are strictly regulated. In 2016, the government introduced a cap limiting the supply of so-called main crops to 15% of the total gross tonnage of inputs per calendar year, with the possibility to spread it over a 3 year period (Decree No. 2016-929 of 7 July 2016), to avoid competition between biomass energy production and food use. N.B.: this cap is specific to France, in addition to the biomass sustainability criteria defined by the European Renewable Energy Directive (RED II) which apply to anaerobic digestion plants. The Decree No. 2022-1120 of 4 Aug. 2022, known as the “crops decree”, put an end to the 3 year smoothing period for injected biomethane production plants. The maximum quantity of main crops now applies to each “biomethane batch” (one batch lasts 12 months), as defined in the decree of 1 February 2023 on the criteria of inputs, sustainability and greenhouse gas emission reductions for biomethane production.

## HOUSEHOLD ORGANIC WASTE AND ASSIMILATED BIOWASTE

This refers to domestic and similar waste. Waste generated by municipal services, sewage systems, street cleaning and markets do not fall within this scope.

## GREEN WASTE

Green waste refers to organic plant refuse resulting from the maintenance and upkeep of green areas (parks and gardens, sports fields, etc.) by local authorities, public and quasi-public organisations, private companies and individuals.

## SLUDGE

This includes sludge treated in urban wastewater treatment plants, as well as sludge from the agri-food industry, i.e., liquid materials from slaughterhouses, dairy factories, biscuit-makers, breweries, canneries, etc.

Photo credits: AdobeStock

Handling and storage of inputs on site. Photo credit: GRDF / SAS VERRIÈRES CÉRÉALES

# 2. KEY FIGURES AND BIOMETHANE INJECTION PLANTS IN FRANCE

## 2.1. KEY FIGURES AS OF 31 DECEMBER 2024[7]

**13.9 TWh/year**
**biomethane plants connected to the network**
+18% end 2024

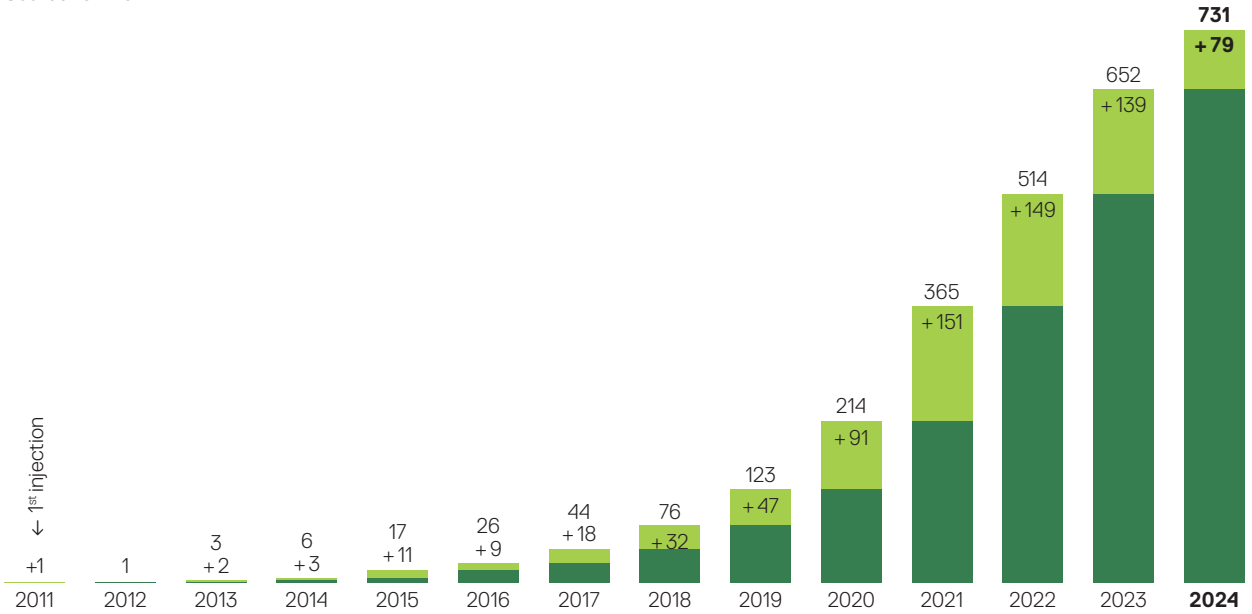
**731**
**biomethane injection sites**
+12% end 2024

**11.6 TWh**
**of biomethane production**[8]
+27% in 2024

**3.2%**
**of natural gas consumption**[9]
in 2024

### TOTAL NUMBER OF PLANTS IN OPERATION AND ANNUAL EVOLUTION

Source: ODRe[10]




7. A watt-hour (Wh) is a unit of measurement used for the production or consumption of energy.
   1 kilowatt-hour (kWh) = 1,000 Wh / 1 megawatt-hour (MWh) = 1,000 kWh / 1 gigawatt-hour (GWh) = 1,000 MWh / 1 terawatt-hour (TWh) = 1,000 GWh
8. Energy injected into the natural gas grid in 2024, the equivalent of approx. 756,000 million new homes or 40,000 trucks/buses.
9. At the end of 2023, 2.4% of France's total natural gas consumption was of renewable origin.
10. Source: Observatory of biomethane sector (ODRe) - https://odre.opendatasoft.com/pages/observatoire-biomethane-v2/#implantation-des-sites.
    Note that one of the facilities commissioned before 2023 has been removed from the total because it has closed definitively.

# 2.2. CHARACTERISTICS OF BIOMETHANE INJECTION FACILITIES IN FRANCE

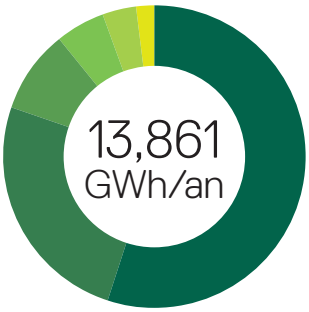
## BREAKDOWN OF TOTAL INJECTION FACILITIES BY TYPE AT THE END OF 2024

Source: ODRe as of 31st of December 2024


- Autonomous agricultural
  **476 sites · 65 %**
- Regional agricultural
  **146 sites · 20%**
- Sludge from wastewater treatment plants (WWTP)
  **52 sites · 7%**
- Regional anaerobic digestion
  **25 sites · 4%**
- Non-hazardous waste storage facilities
  **24 sites · 3%**
- Household waste and biowaste
  **8 sites · 1%**

## BREAKDOWN OF TOTAL FORECAST ANNUAL PRODUCTION[11] BY TYPE OF INJECTION FACILITY AT THE END OF 2024

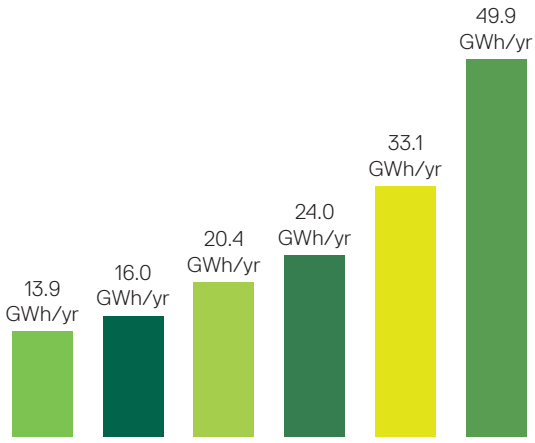
Source: ODRe as of 31st of December 2024




- Autonomous agricultural
  **7 636 GWh/an · 55 %**
- Regional agricultural
  **3 500 GWh/an · 25 %**
- Regional anaerobic digestion
  **1 248 GWh/an · 9 %**
- Sludge from wastewater treatment plants (WWTP)
  **723 GWh/an · 5 %**
- Non-hazardous waste storage facilities
  **489 GWh/an · 4 %**
- Household waste and biowaste
  **265 GWh/an · 2 %**

## AVERAGE SIZE OF BIOMETHANE INJECTION PLANTS BY SITE TYPE AT THE END OF 2024, EXPRESSED IN FORECAST ANNUAL PRODUCTION

Source: ODRe as of 31st of December 2024




- Sludge from wastewater treatment plants (WWTP)
- Autonomous agricultural
- Non-hazardous waste storage facilities
- Regional agricultural
- Household waste and biowaste
- Regional anaerobic digestion

11. The forecast annual production expressed in GWh/yr was calculated based on the following hypotheses: maximum capacity extracted from the capacity register expressed in $m^3(n)/h$, Gross Calorific Value (GCV) of biomethane = 10.9 $kWh/m^3(n)$ and 8,200 hours of annual operation.

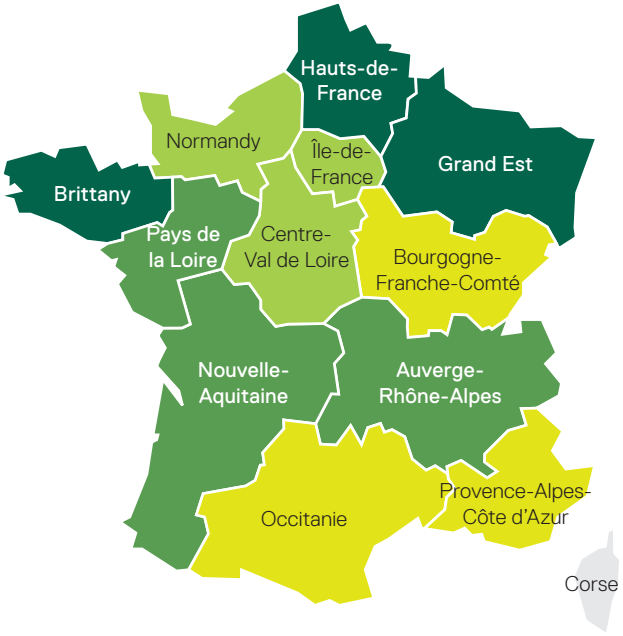
# 2.3. REGIONAL BREAKDOWN OF BIOMETHANE INJECTION FACILITIES IN FRANCE

## REGIONAL DISTRIBUTION OF BIOMETHANE INJECTION SITES AT THE END OF 2024

Source: ODRe as of 31st of December 2024

| 731 sites of which | |
|---|---|
| Grand Est | 127 |
| Hauts-de-France | 100 |
| Brittany | 93 |
| Auverge-Rhône-Alpes | 65 |
| Nouvelle-Aquitaine | 65 |
| Pays de la Loire | 62 |
| Île-de-France | 60 |
| Normandy | 59 |
| Centre-Val de Loire | 41 |
| Bourgogne-Franche-Comté | 26 |
| Occitanie | 26 |
| Provence-Alpes-Côte d'Azur | 7 |
| Corse | 0 |

- ] 90 sites
- ] 60 - 90 ] sites
- ] 30 - 60 ] sites
- ] 0 - 30 ] sites
- 0

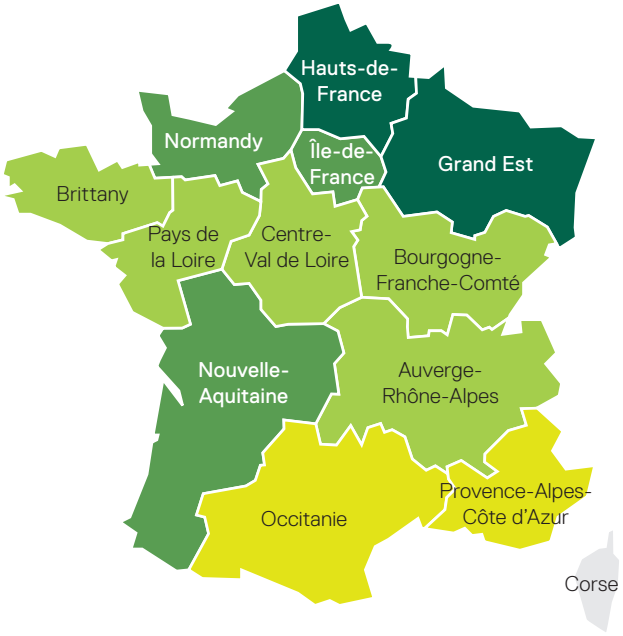



## BREAKDOWN OF TOTAL FORECAST ANNUAL PRODUCTION[12] OF BIOMETHANE INJECTION PLANTS AT THE END OF 2024 (in GWh/year)

Source: ODRe as of 31st of December 2024

| 13,861 GWh/year of which | |
|---|---|
| Grand Est | 2,712 |
| Hauts-de-France | 2,284 |
| Nouvelle-Aquitaine | 1,404 |
| Normandy | 1,226 |
| Île-de-France | 1,215 |
| Pays de la Loire | 1,051 |
| Brittany | 1,048 |
| Auverge-Rhône-Alpes | 843 |
| Bourgogne-Franche-Comté | 723 |
| Centre-Val de Loire | 683 |
| Occitanie | 581 |
| Provence-Alpes-Côte d'Azur | 91 |
| Corse | 0 |

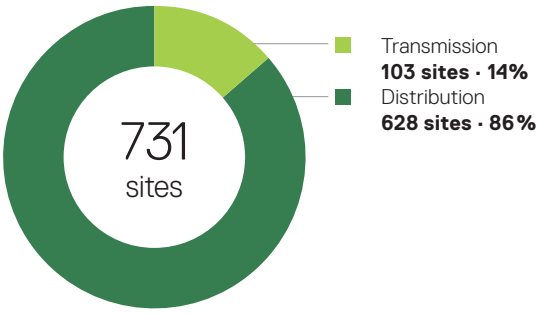
- ] 1,800 GWh/year
- ] 1,200 - 1,800 ] GWh/year
- ] 600 - 1,200 ] GWh/year
- ] 0 - 600 ] GWh/year
- 0




12. The forecast annual production expressed in GWh/yr was calculated based on the following hypotheses: maximum capacity extracted from the capacity register expressed in $m^3(n)/h$, Gross Calorific Value (GCV) of biomethane = 10.9 $kWh/m^3(n)$ and 8,200 hours of annual operation.

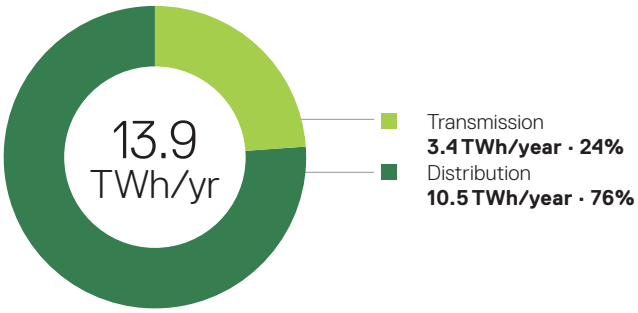
### NUMBER OF BIOMETHANE INJECTION FACILITIES BY GAS NETWORK TYPE AT THE END OF 2024

Source: ODRe as of 31st of December 2024




### FORECAST ANNUAL PRODUCTION OF BIOMETHANE INJECTION FACILITIES BY NETWORK TYPE AT THE END OF 2024

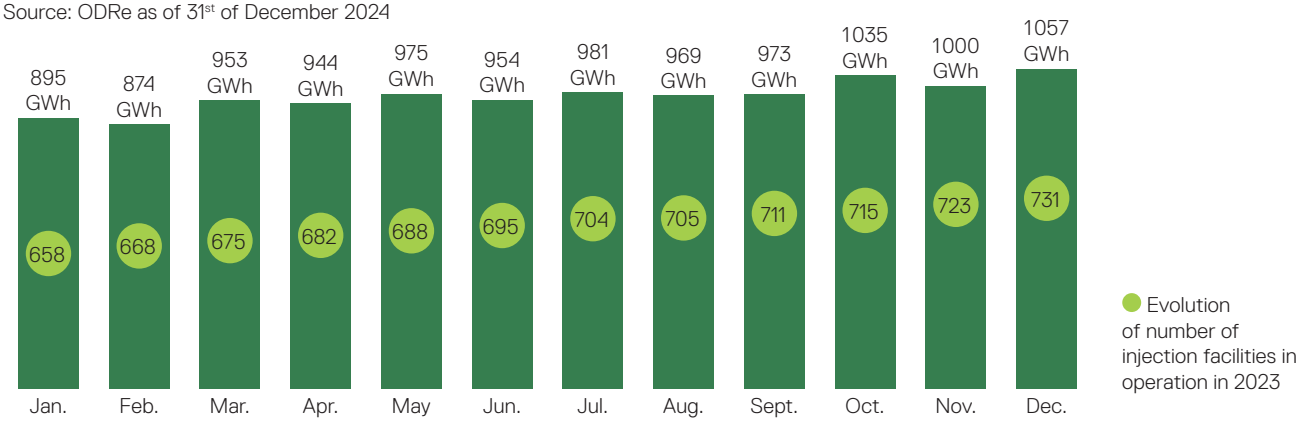
Source: ODRe as of 31st of December 2024




## 2.4. ACTUAL PRODUCTION OF BIOMETHANE INSTALLATIONS IN FRANCE

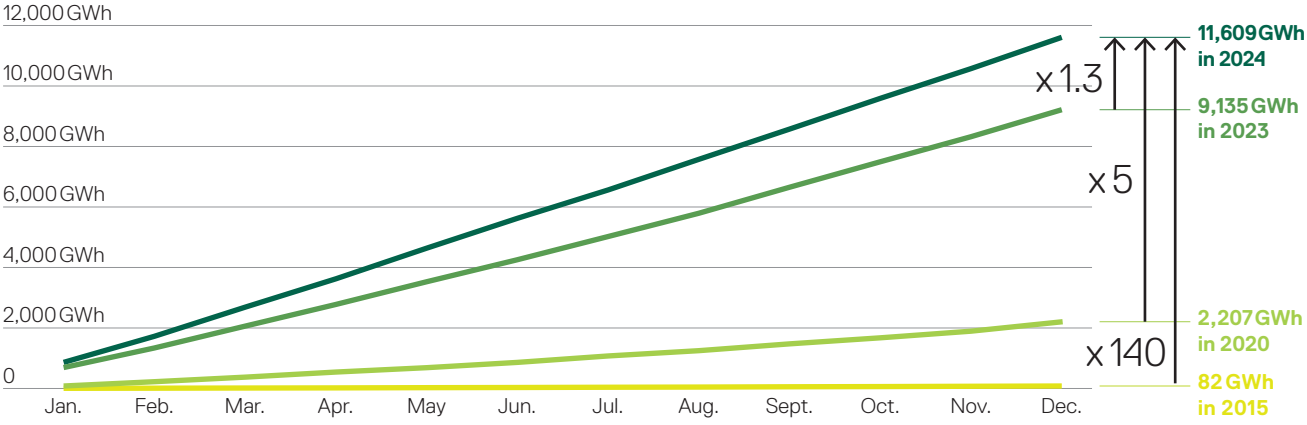
### MONTHLY PRODUCTION OF BIOMETHANE INJECTION FACILITIES IN 2024 (in GWh)

Source: ODRe as of 31st of December 2024




### ANNUAL EVOLUTION OF CUMULATED BIOMETHANE PRODUCTION (in GWh)

Source : ODRe as of 31st of December 2024



## REGIONAL DISTRIBUTION OF BIOMETHANE PRODUCTION IN 2024 (in GWh)

Source: ODRe as of 31st of December 2024

| 11,609 GWh dont | |
|---|---|
| Grand Est | 2,555 |
| Hauts-de-France | 2,066 |
| Nouvelle-Aquitaine | 1,098 |
| Île-de-France | 1,088 |
| Pays de la Loire | 951 |
| Normandy | 948 |
| Brittany | 934 |
| Auverge-Rhône-Alpes | 653 |
| Centre-Val de Loire | 533 |
| Bourgogne-Franche-Comté | 391 |
| Occitanie | 331 |
| Provence-Alpes-Côte d'Azur | 63 |
| Corse | 0 |

- ] 1,500 GWh
- ] 1,000 - 1,500 ] GWh
- ] 500 - 1,000 ] GWh
- ] 0 - 500 ] GWh
- 0

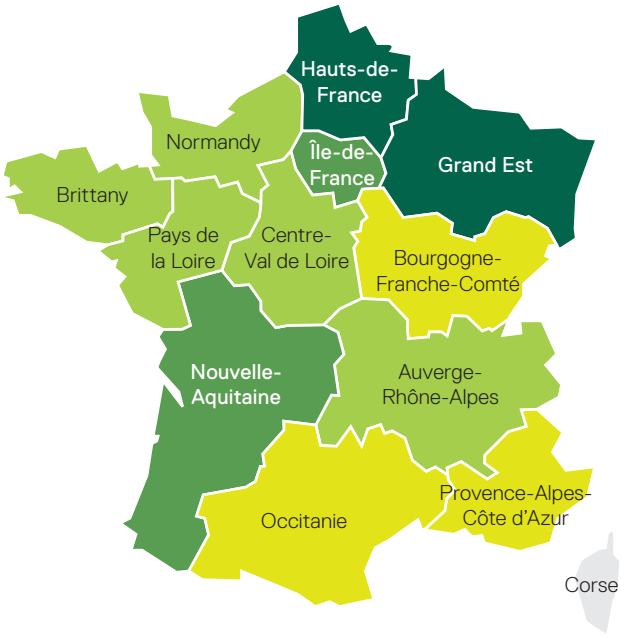


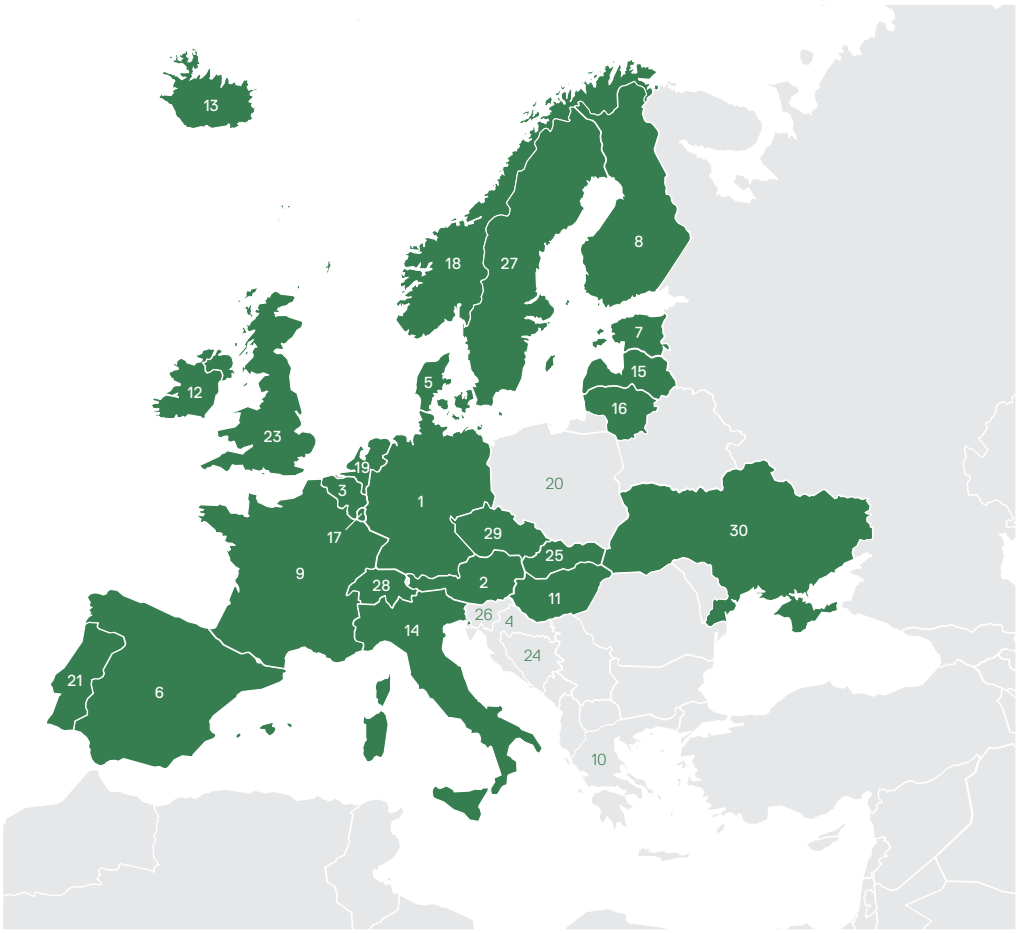

Photo credit: Teréga

# 2.5. MAP OF BIOMETHANE PRODUCTION IN EUROPE

## OVERVIEW OF BIOMETHANE PRODUCTION IN EUROPE

Source: SER, based on EBA (European Biogas Association) Statistical Report 2024 – Tracking biogas and biomethane deployment across Europe
At the end of 2024, only data to the end of 2023 is available for the vast majority of countries, with the exception of France and Latvia, whose data is to the end of 2024, and Luxembourg, whose data is to the end of 2022.

**According to the data available at the end of 2024, there are at least 1,581 biomethane production facilities in the main European producer countries, for a total biomethane production of at least 54.7TWh.**




**1. GERMANY**
In 2023, 258 sites produced more than 13.000GWh of biomethane.

**2. AUSTRIA**
In 2023, 16 sites produced 131GWh of biomethane, of which 14 were injected into the grid.

**3. BELGIUM**
In 2023, 9 sites produced 206GWh of biomethane, of which 7 were injected into the grid.

**4. CROATIA**
At the end of 2023, there is no biomethane production site.

**5. DENMARK**
In 2023, 59 sites produced 7.428GWh of biomethane.

**6. SPAIN**
In 2023, 11 sites produced 252GWh of biomethane.

**7. ESTONIA**
In 2023, 8 sites produced 211GWh of biomethane.

**8. FINLAND**
In 2023, 25 sites produced 242GWh of biomethane, of which 5 were injected into the grid.

**9. FRANCE**
In 2024, 731 biomethane production sites injected 11,609GWh into the natural gas grid.

**10. GREECE**
At the end of 2023, there is no biomethane production site.

**11. HUNGARY**
In 2023, 2 sites produced 90GWh of biomethane.

**12. IRELAND**
In 2023, 2 biomethane production sites injected 60GWh into the natural gas grid.

**13. ICELAND**
In 2023, 2 sites produced 49GWh of biomethane without being connected to the natural gas grid.

**14. ITALY**
In 2023, 96 sites produced 7,800GWh of biomethane.

**15. LATVIA**
In 2024, 7 sites produced 341GWh of biomethane.

**16. LITHUANIA**
In 2023, 1 site produced 90GWh of biomethane.

**17. LUXEMBURG**
In 2022, 16 biomethane production sites injected 61GWh into the natural gas grid.

**18. NORWAY**
In 2023, 16 sites produced 582GWh of biomethane, of which 3 were injected into the natural gas grid.

**19. THE NETHERLANDS**
In 2023, 81 sites produced 2,930GWh of biomethane.

**20. POLAND**
At the end of 2023, there is no biomethane production site.

**21. PORTUGAL**
End 2023, 3 sites produced 22GWh of biomethane.

**22. ROMANIA**
At the end of 2023, there is no biomethane production site.

**23. UNITED KINGDOM**
In 2023, 120 sites produced 7,500GWh of biomethane.

**24. SERBIA**
At the end of 2023, there is no biomethane production site.

**25. SLOVAKIA**
In 2023, 1 site produced 63GWh of biomethane.

**26. SLOVENIA**
At the end of 2023, there is no biomethane production site.

**27. SWEDEN**
In 2023, 71 sites produced 1.542GWh of biomethane.

**28. SWITZERLAND**
In 2023, 47 sites produced 437GWh of biomethane.

**29. CZECH REPUBLIC**
In 2023, 10 sites produced 103GWh of biomethane.

**30. UKRAINE**
In 2023, 2 sites produced 30GWh of biomethane.

# 3. INJECTION CAPACITY RESERVATIONS AS AT 31 DECEMBER 2024[13]

29.2 TWh/year
in the register
+9,8 % in 2024
**including 15.4 TWh/year pending**
and also including:
· 28.46 TWh/yr anaerobic digestion projects
· 0.71 TWh/yr pyro-gasification projects
· 0.03 TWh/yr power-to-methane projects

1,358 projects listed
in the register
**including 983 pending**
and also including:
· 1347 projets de méthanisation
· 7 projets de pyrogazéification
· 4 projets power to méthane

**In order to monitor the development of the sector, a register has been set up, shared by all grid operators, for projects requesting to be fed into the grid. The register makes it possible to manage capacity reservations, track the progress of projects from the study phase through to production, and draw up projections for the future development of the sector.**

In 2022, the capacity register was opened up to all renewable and low-carbon gases, whatever the production technology[14]. The data in the register therefore includes projects for injecting gas from complementary technologies (see pages 33 to 39): pyro-gasification, hydrothermal gasification and power-to-methane.

The cumulative forecast annual production[15] of the 1,358 projects registered in the capacity register amounts to 29.2 TWh/year, including 15.4 TWh/year in queue. These production capacities could be commissioned before 2027, with each project taking between 2 and 5 years to be completed.

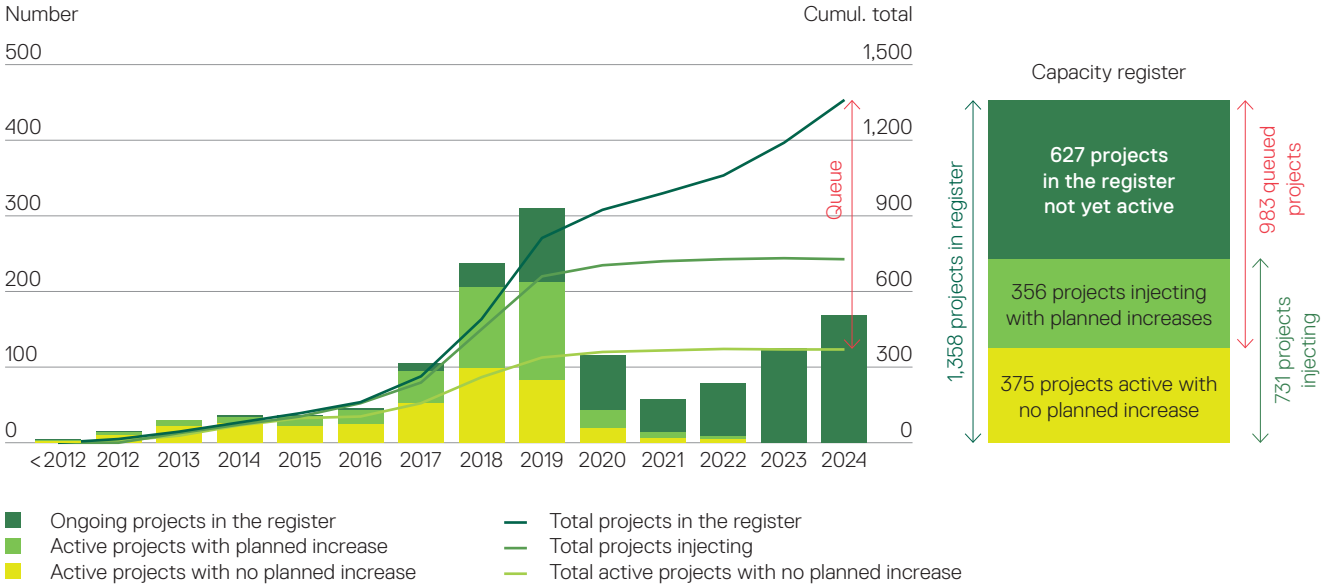
### WHY THIS NOTION OF A QUEUE?

The **queue** includes all projects that have not yet reached their maximum operating capacity. This visualisation separates the projects and annual production forecasts in operation from the projects and annual production forecasts to come. It also highlights the fulfilment of forecast annual production increases for the projects in operation.

13. Source: https://odre.opendatasoft.com/explore/dataset/registre-biomethane-trimestre/information/?flg=fr-fr&disjunctive.trimestre & https://www.naTrangroupe.com/sites/default/files/2022-10/Procedure-registre-capacite-annexe.pdf
14. Source: https://www.naTrangroupe.com/medias/actualites/elargissement-du-registre-des-capacites
15. The forecast annual production expressed in GWh/yr was calculated based on the following hypotheses: maximum capacity extracted from the capacity register expressed in $m^3(n)/h$, Gross Calorific Value (GCV) of biomethane = 10.9 $kWh/m^3(n)$ and 8,200 hours of annual operation.

## NUMBER OF INSTALLATIONS PENDING (MINISTRY DASHBOARD)

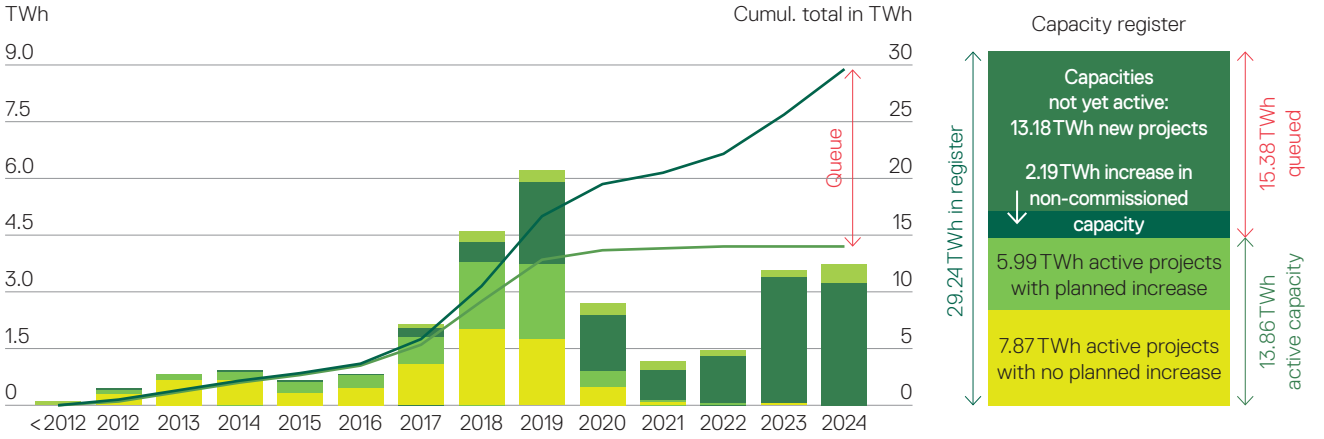
All of France – excluding projects on hold, terminated, abandoned or for which all phases are active.
Including active projects with pending increase.
Source: capacity registry as of 31st of December 2024




- Ongoing projects in the register
- Active projects with planned increase
- Active projects with no planned increase
- Total projects in the register
- Total projects injecting
- Total active projects with no planned increase

## CAPACITY PENDING (MINISTRY DASHBOARD)

All of France – excluding projects on hold, terminated or abandoned.
Including requests for capacity increase.
Source: capacity register as of 31st of December 2024

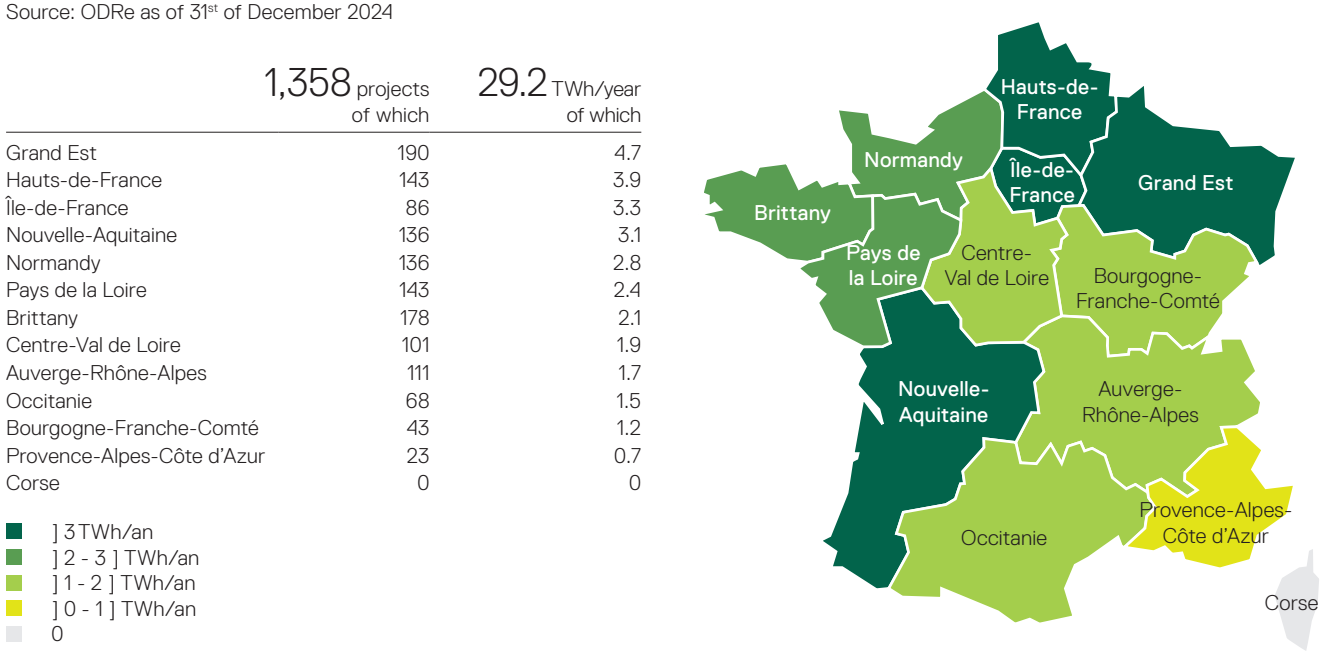



- Pending capacity in the register (increases in progress)
- Pending capacity in the register (projects in progress)
- Active capacity with planned increase
- Active capacity with no planned increase
- Total capacity in register
- Total capacity of injecting projects

## REGIONAL DISTRIBUTION OF FORECAST ANNUAL PRODUCTION[16] OF BIOMETHANE INJECTION PROJECTS IN CAPACITY REGISTER AT THE END OF 2024 (in TWh/year)

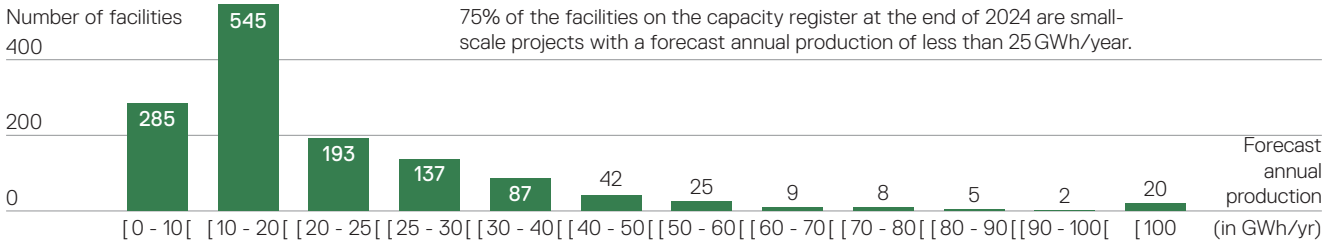
Source: ODRe as of 31st of December 2024

| | 1,358 projects of which | 29.2 TWh/year of which |
|---|---|---|
| Grand Est | 190 | 4.7 |
| Hauts-de-France | 143 | 3.9 |
| Île-de-France | 86 | 3.3 |
| Nouvelle-Aquitaine | 136 | 3.1 |
| Normandy | 136 | 2.8 |
| Pays de la Loire | 143 | 2.4 |
| Brittany | 178 | 2.1 |
| Centre-Val de Loire | 101 | 1.9 |
| Auverge-Rhône-Alpes | 111 | 1.7 |
| Occitanie | 68 | 1.5 |
| Bourgogne-Franche-Comté | 43 | 1.2 |
| Provence-Alpes-Côte d'Azur | 23 | 0.7 |
| Corse | 0 | 0 |



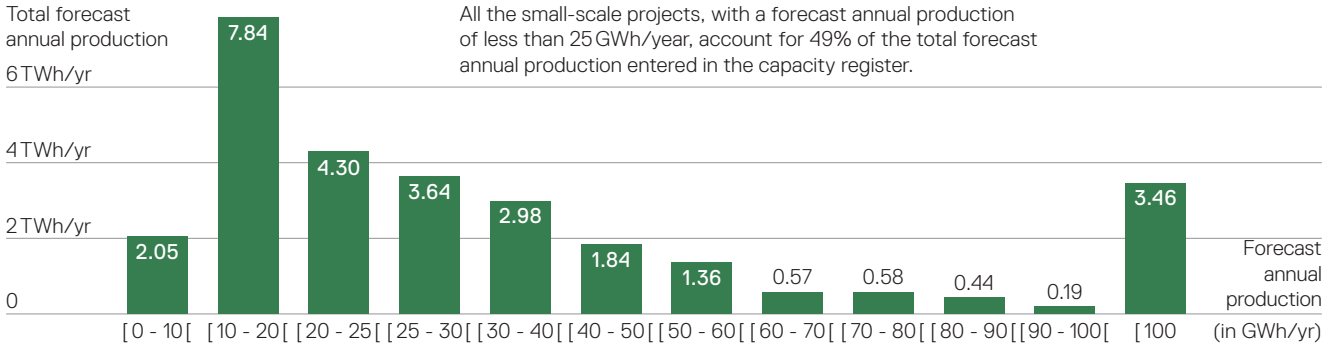

## BREAKDOWN OF THE NUMBER OF PROJECTS IN THE CAPACITY REGISTER BY PROJECT SIZE

Source: Export from the capacity register as of 31st of December 2024




## BREAKDOWN OF TOTAL FORECAST ANNUAL PRODUCTION RESERVED IN THE CAPACITY REGISTER BY PROJECT SIZE

Source: Export from the capacity register as of 31st of December 2024




16. The forecast annual production expressed in GWh/yr was calculated based on the following hypotheses: maximum capacity extracted from the capacity register expressed in $m^3(n)/h$, Gross Calorific Value (GCV) of biomethane = 10.9 $kWh/m^3(n)$ and 8,200 hours of annual operation.

# A FOCUS ON MOBILITY

## BioNGV/NGV: ACCELERATING THE ENERGY TRANSITION

**Essential to our modern economy and society, the transport sector is faced with a range of environmental, economic, social and regional challenges. It must meet the growing demand for mobility and logistics while drastically reducing its environmental impact.**

*BioNGV comes in two forms: Compressed Natural Biogas (BioCNG) and Liquefied Natural Biogas (BioLNG). BioCNG is the most widespread form, and comes in the form of a gas compressed to between 200 and 250 bars contained in tanks. It is used for passenger cars and heavy goods vehicles. BioLNG is the liquid form and is currently reserved for heavy goods vehicles. This focus deals only with BioCNG/CNG.*

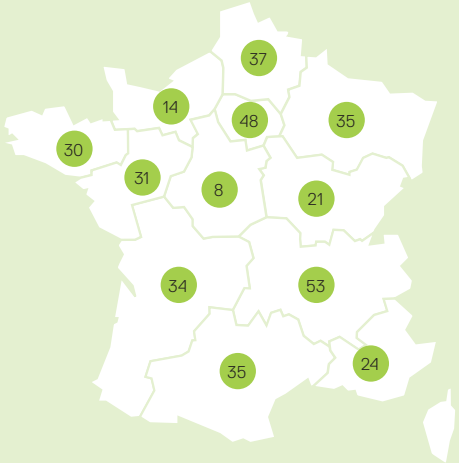
The history of BioNGV/NGV in France began with buses, particularly in Poitiers, which acquired its first vehicles at the end of the 1990s. With a view to the circular economy and energy sovereignty, biomethane in the form of BioNGV is gradually becoming the preferred choice for decarbonising mobility, particularly buses, coaches and refuse collection vehicles. Today, these markets are well established:

- All towns with more than 200,000 inhabitants use CNG buses, coaches or refuse collection vehicles.
- Nearly 50% of buses sold in France over the last three years run on BioNGV/GNV, as do one in four refuse collection vehicles.

There are currently more than 13,500 BioNGV/NGV HGVs on the road in France. While large-scale distribution remains the main user, this fuel is gaining ground in urban delivery, courier services, construction and other sectors.

### REGIONAL BREAKDOWN OF THE NUMBER OF PUBLIC-ACCESS BIOGAS/GNV FILLING STATIONS IN MAINLAND FRANCE AT THE END OF 2024

Source: GNV Observatory - Open Data Réseaux Energies (ODRe) (opendatasoft.com)
https://odre.opendatasoft.com/pages/observatoire-gnv/#points-davitaillement




**BioNGV/NGV is going through an uncertain period, despite some encouraging signs:**

BioNGV as emission-neutral, making it even more attractive. However, the recent vote on the European regulation on $CO_2$ emissions from heavy goods vehicles, which will see the end of new internal combustion vehicles in 2040 (2035 for city buses), raises questions about the future of BioNGV. However, the addition of a carbon correction factor by 2027 remains a possibility. Against this backdrop, players such as Eurogas are campaigning for the approval of 100% BioNGV vehicles as carbon-neutral, while announcements from Scania and Iveco promise more powerful engines and greater range. The refuelling network is also continuing to expand, with 55 new stations connected to the GRDF distribution network planned for 2024, bringing the total number of public stations to 370. These advances, combined with the award of the Crit'Air 1 sticker for BioNGV vehicles, make them an economical solution that is suitable for professionals operating in low-emission zones. At the same time, the government is finalising its first call for projects for the production of non-injected biomethane for fuel use.

BioNGV, which reduces $CO_2$ emissions by up to 80% compared with diesel emissions, is emerging as a key response to the decarbonisation of the transport sector and is set to become the majority fuel in the long term. To support transport operators, GRDF offers practical tools:

- Analysis of total cost of ownership (multi-fuel)[17];
- Calculation of avoided $CO_2$ emissions;
- Identification of flows compatible with BioNGV.

### SOME KEY BioNGV/NGV FIGURES

Source: OpenData, FMB, data as at end of 2024

- **3,121 light vehicles**
- **11,101 light utility vehicles**
- **13,605 heavy duty vehicles**
  the French NGV truck fleet is the largest in Europe
- **10,045 buses and coaches**
  **5,645 garbage trucks and sweepers**
  (nearly 15% of total)
- **+55 stations connected to GRDF grids in 2024**
  for a total of more than 700 stations in service, of which 370 are public-access stations
- **53,8% of CNG used in France in 2024 is renewable**

17. Source : https://www.grdf.fr/acteurs-gnv/vehicules-roulant-gnv/realisation-projet/tco-vehicule-diesel-gnv

# 4. REGULATORY AND ECONOMIC FRAMEWORK

## 4.1. THE REGULATIONS GOVERNING THE DEVELOPMENT OF THE SECTOR

**The development of the anaerobic digestion sector, which produces biogas/biomethane, is strictly regulated. The regulatory framework for the production of biomethane has undergone numerous changes since the first measures were introduced in 2010.**

| | | |
|---|---|---|
| 2010 | **Outlines of 1st public support scheme for injected biomethane.** | National Renewal Energy Action Plan (NREAP) |
| 2011 | Regulatory framework of **1st feed-in tariffs for injected biomethane.** | Tariff Order of 23 November 2011 |
| 2016 | The State can use **calls for tender** in addition to feed-in tariffs. | Order No. 2016-411 of 7 April 2016 |
| 2018 | Provisions related to the **compliance of biomethane injection plants**, with **feedstock sustainability and greenhouse gas emission criteria.** | Renewable Energy Directive II (RED II) |
| 2020 | **Production targets for biomethane injection:**<br>• 6 TWh in 2023, between 14 and 22 TWh in 2028;<br>• And 9.7 billion euros to support the renewable gas industry.<br>**Continuation of feed-in tariffs for plants < 300 Nm³/h** (≈ 25 GWh/year) and launch of **1st calls for tender beyond this threshold.** | New Multi-Annual Energy Plan (MAEP) Decree No. 2020-456 of 21 April 2020 |
| | **Modification of regulatory framework:**<br>• (1) New provisions for injected biomethane feed-in tariffs;<br>• (2) New regulated tariff for all injection plants < 300 Nm³/h. | (1) Decree No. 2020-1428<br>(2) Tariff Order of 23 November 2020 |

## 2021

**Modification of specific provisions related to the sale of biogas:**

- Regulatory framework of calls for tender for injected biomethane and future calls for proposals for non-injected biomethane to be used as fuel (BioNGV)
- Provisions related to biomethane injection plant monitoring
- Technology-neutral definition of biomethane, which includes all recovery processes of biomass in gaseous form for injection

Decree No. 2021-1273 of 30 September 2021

**Possibility** of creating support through **calls for proposals for electricity or biogas plants using renewable energy or innovative technologies.**

Decree No. 2021-1280 of 1 October 2021

**Shift from the notion of** "maximum production capacity" (in $Nm^3/h$) to **"forecast annual production" (in GWh/yr)**. Sets feed-in tariff (unchanged from the previous one) for all injection plants < 25 GWh/yr.

Tariff order of 13 December 2021, amending that of 23 November 2020

## 2022

- In April, **the specifications listing the terms and conditions for the injected biomethane call for tender were published** on the French Energy Regulatory Commission website.
- At the beginning of December, the Minister of Energy Transition suspended the 1st stage of the call for tender, initially planned from 2 to 16 December 2022. **The call for tender has been postponed to 2023 in order to co-define new terms and conditions, reflecting the rise of energy costs, with the industry stakeholders.**

Injected biomethane PPE2 call for tender

Publication of regulatory documents:

- (1) On the **feed-in tariff increase** for injected biomethane and its inflation indexation
- (2) On the **extension of the commissioning period** for certain biomethane injection plant projects.

(1) Tariff Order of 20 September 2022 amending that of 13 December 2021

(2) Decree No.2022-1248 of 20 September 2022

**1st regulatory measures for the future extra-budgetary support scheme based on Biogas Production Certificates (BPCs).**
BPCs aim at encouraging the production of injected biomethane by setting a minimum rate of biomethane to be included in natural gas supplier portfolios for the coming years.

Decree No.2022-640 of 25 April 2022

**Call for expressions of interest (CEI, AMI in French) on pyro-gasification for injection:** led by NaTran as part of the work of the "New Energy Systems" Strategic Industry Committee (SIC, CSF in French)[18], this CEI identified 49 projects in 11 French regions. **These projects aim to convert solid waste into renewable, low-carbon gas,** with a total production capacity estimated at 4.1 TWh/year.

18. The Strategic Industry Committees (SICs) were set up in 2010 to develop industry in France. The Strategic Sector Committees bring together manufacturers, government and trade unions within the National Industry Council, chaired by the Prime Minister.

## 2023

**Modification and adjustment of feed-in tariffs for all installations with:**

- (1) An **increase in tariffs**.
  **Annual indexation**, which now includes an **index reflecting the cost of energy**.
  A better reflection of cost trends.
  Annualisation of the Cmax (maximum production capacity).
  The reintroduction of the possibility to benefit from an investment support from ADEME under certain conditions.
- (2) Fixing the feed-in-tariff if the forecast annual production is exceeded (valued at the daily price recorded on the natural gas wholesale market).

(1) Tariff order of 10 June 2023 amending that of 20 September 2022

(2) Order of 10 June 2023 setting the tariff for biomethane injected and delivered to the co-contractor in excess of the forecast annual production

**Possibility of modifying the FAP or Cmax of installations:**
Authorisation to modify forecast annual production or maximum production capacity once per period of 12 months, instead of 24 months, for the 24 months following publication of the decree. The decree also makes it possible to extend, for an unlimited period, the commissioning deadline in the event of an appeal for purchase contracts signed after 24 November 2020.

Decree no. 2023-456 of 10 June 2023

**Changes to the terms of application of the feed-in tariff following the call for tenders:**

- **Opening of the call for tenders to innovative technologies:** power-to-methane", pyrolysis and gasification.
- The **cumulative duration of the periods of suspension of the deadline for a purchase contract to take effect** has been increased from two to **three years for purchase contracts signed before 24 November 2020** (amendment to the decree of 30 September 2021).

Decree no. 2023-809 of 21 August 2023

**Publication of the first phase of the call for tenders for biomethane injection.**
The deadline for applications is February 2024.

Injected biomethane PPE2 call for tender of 22 December 2023

Photo credits: Grégory Bandel / GRDF

2024

**Publication of the latest regulations on Biogas Production Certificates (BPC).**

- The decree sets the return of BPCs for natural gas suppliers, with a progressive trajectory of 0.8 TWh PCS in 2026, 3.1 TWh PCS in 2027 and 6.5 TWh PCS in 2028[19]. The first penalties for non-restitution will apply in July 2028.
- The decree specifies the BPC emission coefficients according to the age and type of installation (1 BPC per 1 MWh injected for new installations) and sets the penalty at 100€ per missing BPC.

Decree no. 2024-718 of 6 July 2024

Order of 6 July 2024 on the biogas production certificate scheme

**These documents clarify the support framework for the biomethane sector, particularly for large-scale facilities,** with issues to be monitored in terms of the post-2028 trajectory, the indexation of the penalty to inflation and the implementation of the BPC register and the BPC exchange platform.

**State auctions of biomethane guarantees of origin (GOs).**
The decree of 4 July 2024 provides a framework for the allocation of biogas GOs to local authorities and introduces a preferential purchase right for biomethane producers under a purchase obligation contract, in accordance with article L. 446-22 of the Energy Code. It sets out the procedures for transferring the GOs to the municipalities, groups of municipalities and metropolitan areas where the biomethane is produced, as well as the rules for purchasing before or after the auctions.
**The first auctions of biomethane guarantees of origin (GOs) took place in December 2024,** with an average reference price set at 9.50€/MWh, according to EEX, the operator of the GO registry. No preferential purchases or pre-emptions by local authorities were recorded for this first session.

Decree no. 2024-681 of 4 July 2024

**Call for expressions of interest (CEI) on Hydrothermal Gasification (GH) for injection:** led by NaTran as part of the work of the "New Energy Systems" Strategic Industry Committee (SIC), this CEI identified 24 industrial projects, including 2 demonstrators, spread across most of France. These projects aim **to convert a wide range of waste products into renewable, low-carbon gas,** with the aim of producing 2 TWh/year by 2030, thereby contributing to the energy transition and decarbonisation of industry.

**Results and suspension of the call for tenders for biomethane injection.**
Bercy announced at the end of 2024 that only one winner had been selected in the call for tenders launched in December 2023, for an installation of 37GWh/year of injected biomethane. Due to insufficient subscriptions, this scheme will not be renewed. From 2026, the government will give priority to BPCs to support the development of larger facilities.

Call for tenders PPE2 Injected Biomethane of 22 December 2023

19. The decree actually sets targets in terms of "market shares" rather than "quantities of energy".

## 4.2. SAFETY OF FACILITIES AND ENVIRONMENTAL PROTECTION

**Stakeholders in the anaerobic digestion sector are committed to ensuring the security and safety of facilities and protecting the environment.**

**Anaerobic digestion is strictly regulated by the regulations on Classified Installations for the Protection of the Environment (CIEP, ICPE in French)**, which define the requirements applicable to prevent or reduce any risks and nuisances associated with the operation of a plant.

The General Directorate for Risk Prevention (DGPR) of the Ministry for Ecological Transition also has **a database, ARIA**[20], in which it records any incidents/accidents that may have an adverse effect on public health and safety, agriculture, nature or the environment.

**In comparison to the number of facilities in operation, events attributed to anaerobic digestion plants are following a downward trend and, for the most part, are of low severity.**

Photo credits: Xavier Granet / Evergaz

Feedback on anaerobic digestion-related accidents has led to several changes that have contributed to ensuring that the sector develops in an exemplary and sustainable way:

- The general regulations applicable to anaerobic digestion plants, published in June 2021, include new construction and operation guidelines, reinforcing the provisions related to the management of fire, explosion and pollution risks.

- The publication of a compendium of good agricultural practices by the French National Institute for the Industrial Environment and Risks (INERIS) provides operators, engineers and classified plant inspectors with practical information.

- The Qualimétha label, rolled out at the beginning of 2020 by ATEE, enables industry players committed to a quality approach to have their good practices acknowledged via an independent process, that is recognised by the public authorities.

- The recent implementation of a "contract for anaerobic digestion progress" enables stakeholders to commit to a continuous improvement process via specific actions, adapted to their site and local context.

- The result of collective work carried out in 2023[21], the ABC of safety and anaerobic digestion offers farms an educational and practical approach to understanding the fundamentals of safety on their anaerobic digestion site[22].

- Finally, many players are fully committed to raising awareness among operators and offer ongoing training in safety.

**The entire anaerobic digestion sector is working together to ensure that projects are accepted in different regions and meet societal expectations.**

20. ARIA is the only official CIEP (ICPE) accident database.
21. Guide produced with the support of Club Biogaz de l'ATEE, CTBM, AAMF, Biogaz Vallée, CH4 Process and GRDF.
22. Source: https://projet-methanisation.grdf.fr/sinformer-et-se-former/la-securite-des-unites-de-methanisation-normes-prevention-et-formation

# 4.3. TECHNICAL, ADMINISTRATIVE STAGES AND PLAYERS IN AN ANAEROBIC DIGESTION PROJECT

**Setting up an anaerobic digestion project involves a number of stages before the plant is commissioned. On average, it takes between 3 and 5 years to complete, and involves a large number of players and contacts.**

## PROJECT DEVELOPERS

There are different types of owner of anaerobic digestion projects:

▶ **Farmers**, alone or in groups, account for the majority of project developers. Anaerobic digestion is a sideline to their main activity, enabling them to valorise agricultural and livestock waste to produce energy as an additional source of income, and digestate to fertilise their crops.

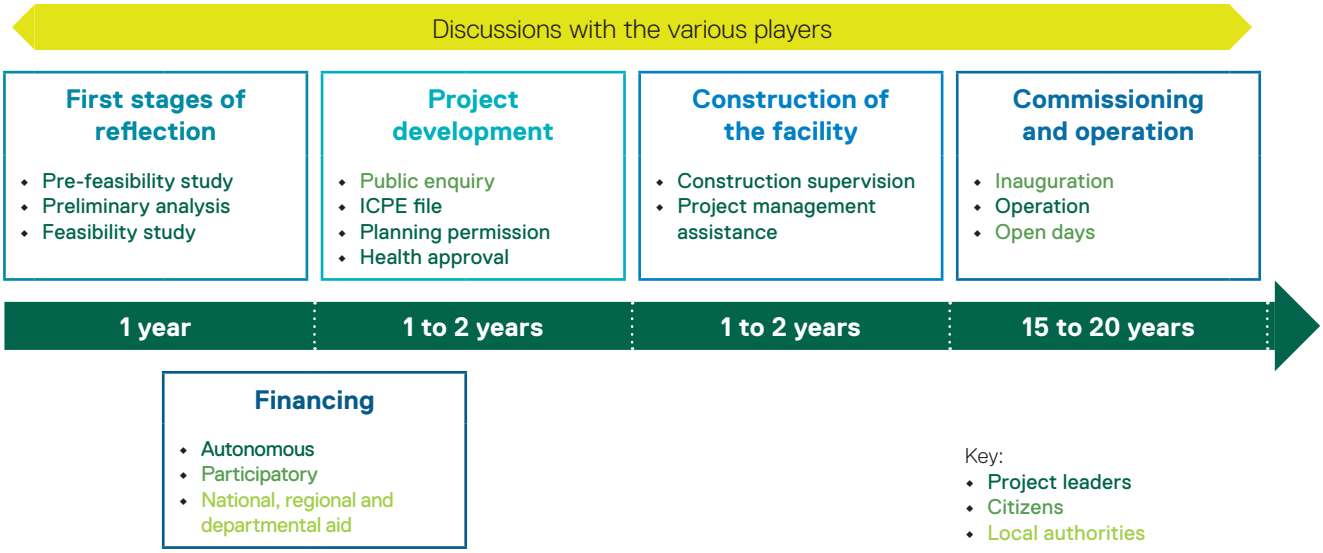
▶ **Specialised companies** that can develop projects by gathering organic materials from a given area.

▶ **Industrials**, particularly in the agri-food, paper and chemical sectors, who may have a project to valorise their organic waste.

▶ **Local authorities** wishing to valorise the organic waste of their residents or the sludges produced at wastewater treatment plants, for which anaerobic digestion is a recovery solution.

▶ **Citizens' groups**, which can be the driving force behind an anaerobic digestion project if they consider this way of valorising their organic waste worthwile.

## THE MAIN TECHNICAL AND ADMINISTRATIVE STAGES OF AN ANAEROBIC DIGESTION PROJECT



## FIRST STAGES OF REFLECTION

The **initial reflection phase** lasts **at least a year**. It allows project developpers to determine the main characteristics of the project: the type and volume of feedstocks, the players involved, the method of biogas valorisation and the location of the plant. This phase of reflection is essential if a responsible and committed project leader is to set up a sustainable and successful project.

## PROJECT DEVELOPMENT

Development continues for **one or two years with more detailed studies**, often carried out by engineering consultants. Then there are the **administrative formalities: Classified Installation for Environmental Protection (CIEP, ICPE in French) procedures** with the prefecture, application for **health approval** if animal by-products are to be processed, application for **planning permission** with the relevant authorities and a **land-spreading plan** for the digestate.

## FINANCING

It is also **during the development phase** that the project developper organises its **financing**, often requesting a **bank loan**. This may be **completed with public subsidies** (in particular from ADEME, regions, or European funds such as the ERDF), crowdfunding from citizens or equity investments. The investments will be remunerated by the sale of the energy produced *via* a support mechanism (feed-in tariff, CPB, over-the-counter mechanism, etc.), determined when the purchase contract is signed.

## CONSTRUCTION OF THE FACILITY

Construction can now begin, which will take **about a year** to complete. It will involve various complementary trades (civil, engineering, public works, etc.). The project developper must continuously monitor the progress of the work. This is **a good time to start training staff** (project developer + operational team).

## COMMISSIONING AND OPERATION

Once all the buildings and equipment have been installed, the site must undergo **tests and checks** to ensure that everything is in order. The site is **inaugurated when it is commissioned**, i.e. when the digester is gradually fed and the biogas begins to be valorised. During its **operation**, the anaerobic digestion plant can organise **open days** to present the facility to the general public and reassure local residents.

## COMMUNICATION AND DIALOGUE

The project developper can involve local residents through **consultation meetings** throughout the development process. He exchanges with all stakeholders (citizens, local authorities, associations, etc.) at various stages. From the very start, **it is advised to inform the public** about the issues at stake, the impact on the landscape and the potential risks. It should also be noted that **facilities subject to CIEP authorisation are required to hold a more in-depth public enquiry** to gather the views of all stakeholders, especially local residents.

Photo credits: Grégory Brandel / GRDF

# 4.4. ENSURING THE TRACEABILITY OF RENEWABLE GAS IN THE GRID

**When injected into the grid, biomethane is mixed with natural gas and can no longer be differentiated. Guarantees of Origin ensure the traceability of injected biomethane, to meet the expectations of users who want to consume more environmentally-friendly gas.**

Biomethane injected into a network mixes with the gas flow in the pipes. However, in accordance with the Energy Code, consumers located anywhere in the country (local authorities, private individuals, industry, etc.) can purchase renewable gas via their supply contract. To do this, **a guarantee of origin (GO) mechanism** is used to separate the physical consumption of the biomethane molecule from its contractual sale to a consumer.

**The GO system ensures the traceability** of biomethane injected into natural gas networks and the associated transactions. **The national GO register,** set up in 2012, is the tool that records the quantities injected, traded and sold, thus tracing each molecule of biomethane produced. EEX manages this register.

▶ To access the Guarantee of Origin register, go to:
**https://www.eex.com/en/markets/energy-certificates/french-auctions-biogas**

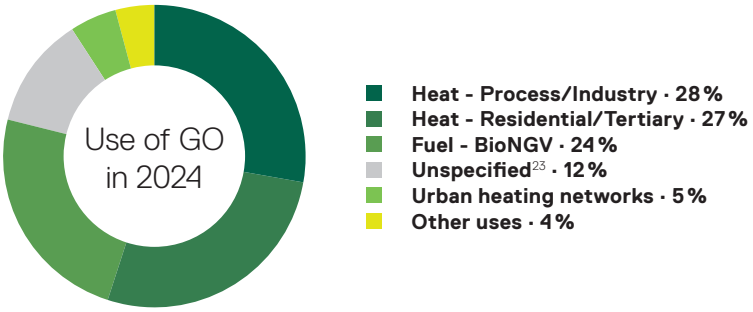
▶ The list of suppliers interested in buying biomethane is available on the Ministry for Ecological Transition website:
**https://www.ecologie.gouv.fr/sites/default/files/20200518-%20liste_fournisseurs.pdf**

## KEY GUARANTEE OF ORIGIN FIGURES IN 2024

Source: European Energy Exchange AG (EEX)

11.5 million **GOs created in 2024**

9.1 million **GOs used/destroyed in 2024**




104
**suppliers listed in the GO register at the end of 2024**

718
**production sites in the GO register at the end of 2024**

1 GO = 1 MWh
**of injected biomethane**

23. The use of GOs is currently declarative in the register. It is therefore not always possible to attribute use to a category. This is why a large proportion of GO use (12%) is currently undetermined.

## A NEW TOOL TO ENSURE THE TRACEABILITY OF BIOMETHANE: BIOGAS PRODUCTION CERTIFICATES (BPC)

The **Biogas Production Certificates (BPC)** scheme was created by Article 95 of the "Climate and Resilience" Act of August 2021 and is designed to encourage the production of biogas injected into natural gas networks and contribute to the energy ambitions set out in the Multiannual Energy Programme (MEP). From 2026, all gas suppliers will have to return a number of BPCs proportional to the consumption of their customers in the residential and tertiary sectors. To meet this obligation, they will have two options: to produce biomethane themselves and inject it into the natural gas networks, or to purchase BPCs from producers of biomethane that has already been injected.

BPCs are created via a dedicated register managed by EEX, which operates in a similar way to the GO register. If a supplier produces its own biomethane, it can request BPCs via its user account. If the supplier obtains supplies from a producer, the producer is responsible for creating the BPCs and then transferring them to the supplier. These certificates provide proof of the consumption of certified sustainable renewable gas, in accordance with the criteria of the European directive on renewable energy, known as "RED".

## A EUROPEAN TOOL FOR HARMONISING TRACEABILITY: THE UNION DATABASE (UDB)

The RED II directive introduced the creation of the **Union Database (UDB)**, a database designed to ensure the traceability of liquid and gaseous biofuels included in Member States' energy transition targets. With the revision of RED II, this system will be extended to all uses beyond transport. Once operational (scheduled to come into force in May 2025, unless the European Commission grants an extension), the UDB will ensure that the quantities of gas accompanied by sustainability certificates entering the EU's interconnected gas network correspond exactly to the quantities leaving it. In practical terms, only guarantees of origin coupled with a "proof of sustainability" will be able to be registered in the UDB. This will enable such proofs to be used in systems such as the European carbon market (ETS).

Wastewater treatment plant in Perpignan (34).
Photo credits: GRDF

# 4.5. ADAPTING EXISTING GAS NETWORKS TO ACCOMMODATE MORE RENEWABLE GAS

**The "right to inject" was designed to adapt the gas infrastructure for the injection of biomethane into the grid. The "right to inject" defines the technical and economic investments required for the injection of biomethane, based on an optimal network planning exercise called "connection zoning". The zoning takes into account active projects in the area and the potential for biomethane in the medium term, resulting in optimally-sized networks in that area. The zoning is carried out by all operators using a methodology that was standardized with the CRE.**

## ■ WHAT TYPE OF INVESTMENT IS POSSIBLE?

This zoning exercise helps identify the network reinforcement investments required to enable projects likely to develop in these areas to have visibility on the available outlets. The different types of investment include:

- Reinforcement of an operator network, including meshing of consumption zones
- Implementation of reverse flow, mainly from distribution networks to transmission networks.

When the Investment/Volume criterion is lower than the fixed regulated threshold of 4,700 €/Nm$^3$/h, the reinforcement investments are covered by the network operator's tariffs.

When the criterion exceeds this threshold, public (energy distribution authorities, local authorities, etc.) or private third-parties (project leaders) can contribute financially to reinforce the zone.

These investments are triggered following their approval by the CRE, and synchronised with the development of projects in each area.

Although in most cases, producers do not have to contribute to the financing of reinforcement investments, they must pay their share for the connections to the network they benefit from (after deduction of the reduction rate), as well as an injection fee[24] set by the CRE to cover any reinforcement-related operating costs. The amount payable by the producer varies depending on the zoning characteristics.

## ■ HOW TO IDENTIFY THE RIGHT PLACES FOR AN INSTALLATION?

### CONNECTION ZONES FOR THE INTEGRATION OF BIOMETHANE INTO GAS NETWORKS

The "right to inject" decree and its implementation in deliberation no.2019-242 of the Commission de Régulation de l'Energie (CRE, French Energy Regulator) is overseeing the integration of biomethane into gas networks. Network operators must work together to define the optimum connection of injection projects in an area, while minimising the cost to the community of adapting the networks.

The costs of network adaptations, according to the technical and economic criteria defined by the "right to inject" decree, may, under certain conditions, be borne by the network operators.

24. The injection fee is a network access fee, set by the CRE, with 3 different levels, depending on the nature of the reinforcement works required in the zone. The level of the fee applicable to each project is specified upon submission of a detailed study.

For information purposes only, operators provide a map of network access conditions.

## NETWORK ACCESS CONDITIONS

Source: Open Data Réseaux Énergies (ODRe)

This map shows an initial order of magnitude for the technical-economic criterion: the lower the value of this criterion, the better the opportunities for network operators to carry out reinforcements to accommodate biomethane in the zone.

https://odre.opendatasoft.com/explore/dataset/cartographie-acces-biomethane/custom/?

## LAYOUT OF GAS DISTRIBUTION AND TRANSMISSION INFRASTRUCTURES

Data on the layout of gas distribution and transport infrastructures is available in opendata. This data can be used to visualise the presence of infrastructure enabling renewable energies to be transported from places of production to places of consumption. Equivalent data is available from the ORE and ODRe agencies for electricity infrastructures.

## MAP LIBRARY

**Data on the layout of gas distribution networks**
can be accessed on the ORE Agency's opendata (datasets and map display).
**Data on the layout of gas transmission networks**
can be accessed on the ODRe opendata (datasets and map display).

### GAS DISTRIBUTION NETWORK INFRASTRUCTURE

Source: ORE Agency

https://opendata.agenceore.fr/explore/dataset/infrastructures-reseau-gaz/map/?

### SIMPLIFIED LAYOUT OF THE GAS TRANSMISSION NETWORK

Source: Open Data Réseaux Énergies (ODRe)

https://odre.opendatasoft.com/explore/dataset/trace-du-reseau-grt-250/custom/?

**NATRAN NETWORK**

https://odre.opendatasoft.com/explore/dataset/terega-trace-du-reseau/map/?

**TERÉGA NETWORK**

**This open-access data can be reused in a number of useful ways:**
buffers can be calculated to represent the territorial coverage of transmission and distribution network services over a width of, say, 20km on either side of the network route.

### 20km WIDTH CORRIDOR ON BOTH SIDES OF THE GAS DISTRIBUTION NETWORK

Source: Open Data Réseaux Énergies (ODRe)

https://odre.opendatasoft.com/explore/dataset/corridor_grd_20_km-nat-grtgaz/information/

### 20km WIDTH CORRIDOR ON BOTH SIDES OF THE GAS TRANSMISSION NETWORK

Source: Open Data Réseaux Énergies (ODRe)

https://odre.opendatasoft.com/explore/dataset/corridor_grt_20_km-nat-grtgaz/information/

## ACCELERATION ZONES FOR THE DEVELOPMENT OF BIOMETHANE PRODUCTION

Law no. 2023-175 of 10 March 2023 on accelerating the production of renewable energy puts local authorities at the heart of planning and requires them to define acceleration zones for the development of renewable energy in their areas. The measure inserted in article L.141-5-3 of the Energy Code complements the regional objectives of the PPE. The acceleration zones (ZAER in French) aim to achieve renewable energy targets based on the potential of the area concerned and the renewable energy capacity already installed.

## POINTS OF INJECTION OF BIOMETHANE INTO NATURAL GAS NETWORKS IN FRANCE AND BIOMETHANE PRODUCTION CAPACITY IN GWh/year

Source: Open Data Réseaux Énergies (ODRe)

https://odre.opendatasoft.com/explore/dataset/points-dinjection-de-biomethane-en-france/table/?

This applies to injection points directly connected to the distribution network, as well as those directly connected to the transmission network (NaTran / Teréga).

## METHANE POTENTIAL DATA BY REGION, DEPARTMENT OR CANTON

Source: Open Data Réseaux Énergies (ODRe)

https://odre.opendatasoft.com/explore/dataset/repartition-des-potentiels-de-methanisation-a-horizon-2050-par-canton/information/?

These data were produced in 2017 by the Solagro association during the production of the study “A 100% renewable gas mix in 2050?” published in February 2018 by ADEME, GRDF and NaTran. They cover the potential accessible from the following primary resources: crop residues, livestock manure, grasses, intermediate energy crops, food industry residues, bio-waste, etc. (in GWh HCV).

Reverse flow station site in Noyal-Pontivy (56), first in France, managed by NaTran.
Photo credit: Julien Gazeau / NaTran

# 5. COMPLEMENTARY TECHNOLOGIES FOR RENEWABLE GAS PRODUCTION

Today, anaerobic digestion is the first mature renewable gas production technology. New renewable and low-carbon gas production processes are also being developed:

### PRODUCTION OF BIOMETHANE AND LOW-CARBON GAS:

- **Pyro-gasification,** a thermochemical conversion process that produces gas from solid residue (humidity levels generally below 20%);
- **Hydrothermal gasification,** a thermochemical process that produces gas from waste or waste mixtures with a humidity level between 50 and 80%;
- **Power-to-methane**, a process that combines $CO_2$ with renewable or low-carbon hydrogen obtained by low-carbon hydrogen obtained by electrolysis of water to produce synthetic methane *via* a methanation reaction.

### PRODUCTION OF RENEWABLE HYDROGEN:

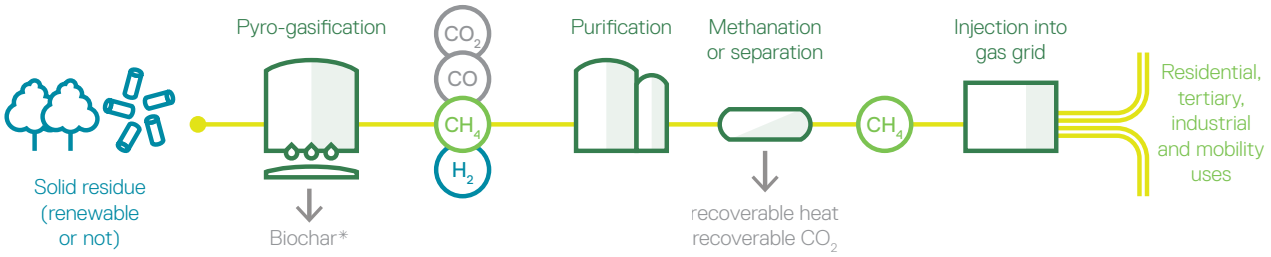
- The production of **renewable hydrogen**, primarily through water electrolysis, a process that converts excess electrical energy into gas.

These technologies make it possible to produce a gas that can be injected into the networks, which will be described as renewable or low-carbon depending on the nature of the input.

# 5.1. PYRO-GASIFICATION OF SOLID RESIDUE

### THE PYRO-GASIFICATION PROCESS

Source: NaTran




* Biochar is a soil amendment produced from the pyrolisis of biomass.

## A SECTOR SERVING THE CIRCULAR ECONOMY

**Pyro-gasification** is a technology that converts matter thermochemically at high temperature (800-1500°C), in the absence of oxygen. It is used to convert into gas various residues that are little or poorly recycled, such as those from the wood industry that are not recycled into materials, furniture waste (WEEE), sorting rejects (certain plastics waste) or Solid Recovered Fuels (SRF), which are often destined for landfill or incineration. This sector thus contributes to the objectives of the laws on the circular economy[25] (AGEC) and on the reduction of landfill waste[26].

Pyro-gasification complements anaerobic digestion, which enables additional local production of renewable, low-carbon gas, and contributes to the decarbonisation of all gas uses (heating, industry, mobility, etc.). A pyro-gasification plant produces energy all year round in the form of renewable gas, which is injected directly into the networks. This ensures stable operation of the plant, optimises its economic profitability and offers a continuous solution for treating waste, without being dependent on the seasons. Its main advantage lies in the fact that it recycles waste without generating any atmospheric emissions, pollutants or odours. Unlike other treatment facilities, the fact that there is no chimney reduces the constraints associated with siting and facilitates local acceptance of the project.

## A SECTOR MOVING TOWARDS INDUSTRIALISATION

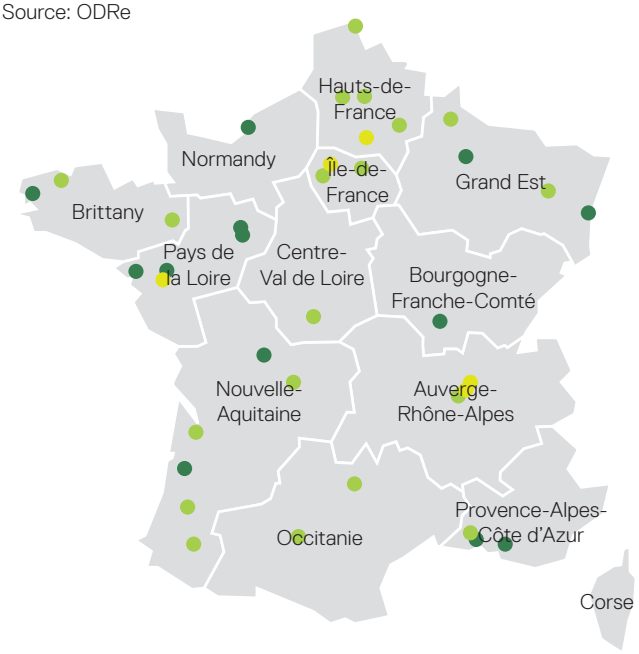
**In 2022, the New Energy Systems Strategic Industry Committee (SIC) launched a call for expressions of interest (CEI) in pyro-gasification** to take stock of the sector in France. The call revealed the existence of a large number of pyro-gasification projects aimed at producing renewable, low-carbon gas for injection, with 49 projects identified representing a cumulative production capacity of 4.1 TWh/year, equivalent to the energy consumption of more than 900,000 new homes. It also highlighted the dynamism of a French industry involving numerous players of all sizes, as well as local authorities. The latter see it as a local solution for recovering waste, reducing the environmental impact of transporting solid materials and supporting a circular economy on a local scale.

Following the return of the results of the CEI to the public authorities, **a project for a first call for projects for pyro-gasification was announced in 2023**, aimed at supporting the first commercial industrial installations for the production of renewable and low-carbon gas injected into the networks. Although 8 projects were registered in 2023, project developers are continuing to strengthen their applications while awaiting the official launch of this call for projects, which is still awaited by the industry.

25. The anti-waste law for a circular economy (AGEC) No. 2020-105 sets the target to recover at least 70% of non-material waste into energy by 2025.
26. Law No. 2015-992 related to energy transition for green growth (LTECV) aims to reduce the amount of non-hazardous non-inert waste sent to landfills by 30% in 2020 compared to 2010 and by 50% by 2025.

## MAP OF PROJECTS TO PRODUCE RENEWABLE, LOW-CARBON GAS BY PYRO-GASIFICATION FOR INJECTION INTO GAS NETWORKS.

Source: ODRe




The industrial nature of the sector enhances its potential for efficiency, thanks to learning effects that are more rapid than those observed in anaerobic digestion, where each project is often led by a different stakeholder. The benefits of the waste management fee should also be taken into account in the economic analysis of projects.

The sector therefore has great potential for rapid production and could play a key role in decarbonising the gas mix. According to ADEME, pyro-gasification could account for up to 30% of the gas mix by 2050, according to various scenarios (Transition(s) 2050 report, re-edited in 2024), provided that appropriate support mechanisms are put in place, particularly for the first commercial industrial units.

### METHAJEHL, A COMMERCIAL INDUSTRIAL PROJECT IN ALSACE

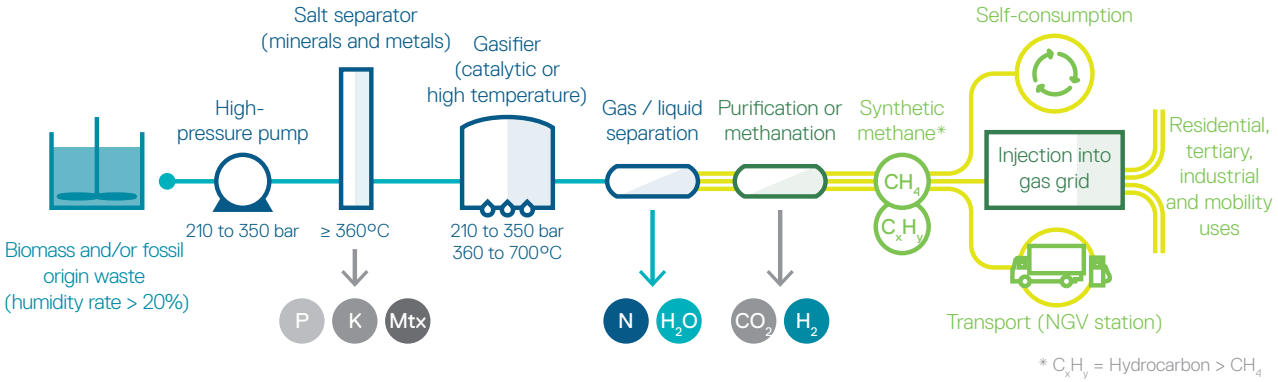
Among the industrial projects identified in France, the METHAJEHL project, located in Alsace and supported by the SG Energies design office and the JEHL TP public works company, aims to process 9,200 tonnes of the company's wood waste to produce 25 GWh/year of biomethane. Part of this will be used to decarbonise the company's fleet.

In addition to reducing the carbon footprint of JEHL and its partners, the project will serve as a replicable benchmark for the production of biomethane from local wood waste and dry solid waste resources that are still little or poorly recovered, as part of a circular economy approach.

# 5.2. HYDROTHERMAL GASIFICATION

### THE HYDROTHERMAL GASIFICATION PROCESS

Source: NaTran/Cerema




## A GAS PRODUCTION AND ORGANIC WASTE RECOVERY SECTOR

Hydrothermal gasification is a thermochemical process that converts and recovers as fully as possible any type of waste, of biomass and/or fossil origin, alone or in a mixture, containing or easily mixable with water. As well as producing a renewable or low-carbon gas at the end of the process, the technology optimises the degree of recovery of waste by its ability to recycle solid (minerals, metals, nitrogen) and liquid (excess water, over and above the proportion permanently recycled to meet process requirements) co-products. Operating in the mandatory presence of water under supercritical, high-pressure (210 to 350 bar) and high-temperature (360 to 700°C) conditions, the technology produces a synthesis gas that is very rich in methane and hydrogen. The process also destroys all traces of pollutants and pathogens, and recovers any microplastics in the gas, while greatly limiting the amount of end-waste, especially heavy metals.

Hydrothermal gasification is capable of recovering a wide range of waste products:

- Mainly of organic origin (industrial waste and effluents (agri-food, chemicals, pharmaceuticals, paper, etc.), bio-waste and the organic fraction of urban waste, sludge from municipal or industrial wastewater treatment plants, agricultural waste and effluents including livestock effluents, digestate from anaerobic digestion plants that cannot be spread locally.

- But also waste of potentially fossil origin from a wide range of industrial and urban activities, such as a lot of plastic waste, soiled or mixed, solvent waste, paint waste, etc., which is not, or only with difficulty, recyclable in its current state, thus avoiding incineration and landfill.

## A TECHNOLOGY THAT SIGNIFICANTLY INCREASES THE OVERALL LEVEL OF WASTE RECOVERY

Hydrothermal gasification maximises gas production through a very high carbon conversion rate, ranging from 85 to 99% depending on the input. The overall energy efficiency ratio ranges from 75 to 85%, thanks to the highly efficient heat management required for the process.

The process operates continuously within a modular, compact installation, enabling any eligible input to be transformed and recovered almost instantaneously.

In addition, hydrothermal gasification is part of a circular economy by recycling the liquid and solid components of waste and recovering them as co-products. Depending on the type of input, it recovers metals, nitrogen, mineral salts such as phosphorus (P) and potassium (K), which can be used as fertilisers, and water. This process greatly reduces, if not eliminates, final waste.

Hydrothermal gasification therefore represents a particularly complete waste recovery technology, which can replace incineration, landfill or any other treatment with a lower energy and/or economic value.

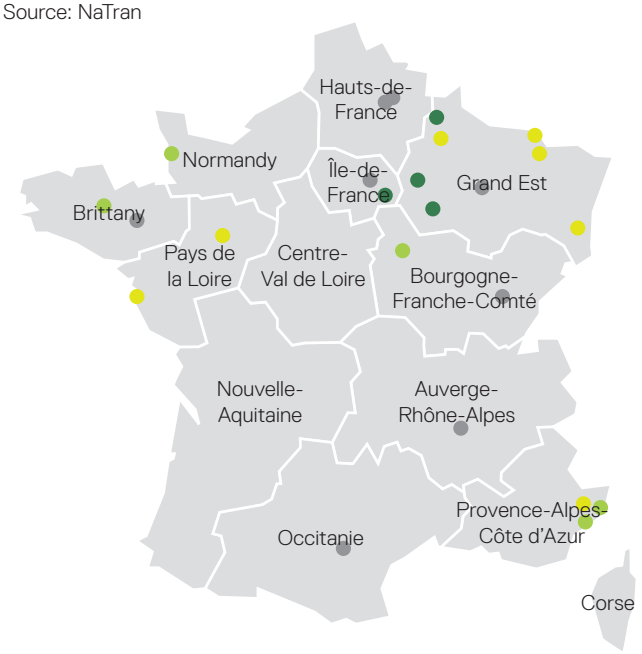
## FRANCE'S HYDROTHERMAL GASIFICATION SECTOR CONTINUES TO TAKE SHAPE

More than fifty multi-disciplinary players, grouped together in the National Hydrothermal Gasification Working Group (GT GH), are working to structure the industry and aim for its industrialisation in France by 2027. Following the publication of an initial white paper in February 2023, taking stock of the technology and the industry in France and Europe, 2024 saw the launch of a call for expressions of interest dedicated to this technology. The aim of this call for expressions of interest was to give a greater boost to players in the French sector, while identifying potential industrial projects in the industrial, urban and agricultural sectors.

## A CALL FOR EXPRESSIONS OF INTEREST (CEI) HYDROTHERMAL GASIFICATION LISTS 24 PROJECTS

### MAP OF HYDROTHERMAL GASIFICATION PROJECTS SUBMITTED TO THE CEI

Source: NaTran




- Agricultural project
- Urban project*
- Industrial project
- Confidential project

* Local authorities, waste and wastewater treatment associations, private waste managers, etc.

**On 4 December 2024, NaTran, with the support of the "New Energy Systems" Strategic Industry Committee, presented the results of its call for expressions of interest (CEI) in hydrothermal gasification.** Organised between September and October 2024, the CEI identified 24 projects across 10 French regions, led by players in the industrial, urban and agricultural sectors. These projects represent a capacity to recover 1.25 million tonnes of waste per year, with a potential production of 2 TWh/year of injectable gas (equivalent to the heating needs of 175,000 French households), including at least 1.3 TWh/year of renewable, low-carbon gas.

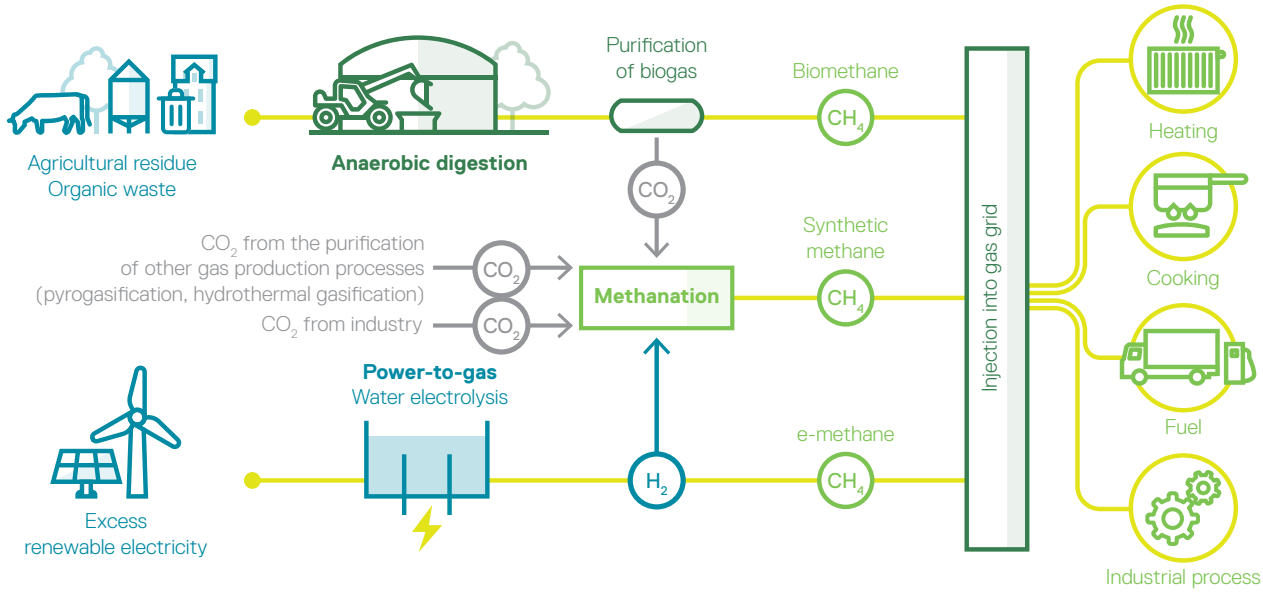
The majority of projects come from the industrial sector, particularly the agri-food and chemical sectors, which account for more than 50% of project applicants. For these industries, the technology makes it possible to replace part of their fossil gas purchases with gas produced from their own waste, while avoiding incineration. As such, hydrothermal gasification contributes to the decarbonisation of waste processing and energy use, enhances the resilience of local areas and is part of a circular economy dynamic.

These positive results will enable the industry to continue structuring itself to develop and commission the first demonstrator projects from 2026, followed by the first industrial projects in 2027. They also pave the way for the definition of support mechanisms, such as experimentation contracts based on the Dutch model, and the simplification of the regulatory framework (ICPE) to facilitate the deployment of industrial projects in France. The technology is expected to be deployed more widely, with the potential to produce up to 12 TWh/year of injectable synthetic methane by 2035, and at least 50 TWh/year by 2050.

# 5.3. POWER-TO-METHANE

### THE POWER-TO-METHANE PROCESS

Source: GRDF




**Power-to-methane** consists of producing synthetic methane, or "e-methane", by combining hydrogen from electrolysis (power to gas) to obtain hydrogen, with a methanation stage designed to combined this hydrogen with CO2, which may come from the purification of biogas (bioCO2) or be captured in industrial flue gases (fatal CO2 from the process or from combustion).

In addition to the direct uses of hydrogen, methanation can generate renewable gas that can be directly injected and stored in the gas infrastructure and used to decarbonise all types of consumption (heat, transport, electricity, raw materials). The ADEME forecast scenario, "Transitions 2050" and the NégaWatt 2022 scenario highlight the role methanation can play in balancing and completing the energy system.

Given the large storage capacity and flexibility of gas infrastructures, many European countries have already initiated research into power-to-methane, with more than ten methanation demonstrators, such as the Store&Go project (Germany, Switzerland, Italy). Commercial power-to-methane units have also been commissioned, such as Hitachi Zosen INOVA's Limeco project (Switzerland) since 2022, and Nature Energy's Power-to-X project (Denmark) in 2023, which represents the largest power-to-methane site in the world, increasing the biomethane production of the anaerobic digestion plant with 12,000 $m^3$/day of e-methane.

Adopting an international approach, Japan has set itself the ambitious target of integrating 1% e-methane into its networks by 2030, and 90% by 2050[27].

## A SECTOR THAT MAXIMISES SYNERGIES BETWEEN ENERGIES AND BETWEEN RENEWABLE ENERGY PRODUCTION TECHNOLOGIES

Power-to-methane promotes circularity between renewable gas production technologies, by recovering the bioCO2 from the purification of biogas produced by the anaerobic digestion or gasification of biomass. What's more, converting this bioCO2 into methane increases the total quantity of renewable gas produced and injected, while preserving the return to the soil for the same quantity of biomass mobilised. Finally, the methanation process generates heat that can be recovered locally.

This complementarity underlines the benefits of developing methanation and power-to-methane together with other technologies in regions producing renewable gas and electricity. Power-to-methane is one of the Carbon Capture and Usage (CCU) technologies promoting a transition towards greater circularity..

27. Source: Strategic Energy Plan, p.100, Agency for Natural Resources and Energy / Ministry of Economy, Trade and Industry of Japan.

# 5.4. RENEWABLE HYDROGEN

### THE PRINCIPLE

Hydrogen enables to tap into the full potential of variable renewable energy by converting it into a storable medium. It offers a decarbonisation solution for a number of industrial and mobility-related usages, and is complementary with other renewable energies and, in particular, renewable gas.

## ■ STRONG FRENCH AND EUROPEAN GROWTH

### RENEWABLE AND LOW CARBON HYDROGEN: ONE OF THE PILLARS OF FRANCE AND EUROPE'S DECARBONISATION STRATEGY

Renewable and low-carbon hydrogen is one of the pillars of the future French and European energy mix, alongside other renewable gases and electricity. Indeed, the European Union and France see it as a key solution for achieving carbon neutrality targets, particularly in certain industrial sectors where it is used as a raw material or in processes that are difficult to electrify, as well as for heavy mobility. Hydrogen also makes it possible to harness the full potential of variable renewable energies by converting them, via water electrolysis, into a storable form.

France was one of the first countries to adopt a Hydrogen Plan in 2018. It was supplemented in 2020 by the Stratégie Nationale Hydrogène, which sets a target of deploying 6.5 GW of electrolysis production on French soil by 2030. In the France 2030 investment plan, 9 billion euros are earmarked to support the deployment of a competitive low-carbon, renewable hydrogen electrolysis sector.

### TOWARDS A NATIONAL HYDROGEN TRANSPORT NETWORK, INTERCONNECTED WITH OUR EUROPEAN NEIGHBOURS

In France, the production of renewable, low-carbon hydrogen is primarily intended to replace existing fossil hydrogen production (in the fertilizer production and refining sectors) and to enable the development of new uses, such as in the steel and chemical industries, as well as for the production of synthetic fuels. The National Hydrogen Strategy forecasts a need for 600,000 tonnes of decarbonated hydrogen by 2030, and 1 million tonnes by 2035.

To meet these challenges, hydrogen production projects using electrolysis are being developed in the main industrial basins where decarbonization is a key issue, such as the Fos-Marseille, Dunkirk and Saint-Nazaire basins, and in the Rhône, Seine and Rhine valleys, complemented by projects to import hydrogen or its derivatives by sea.

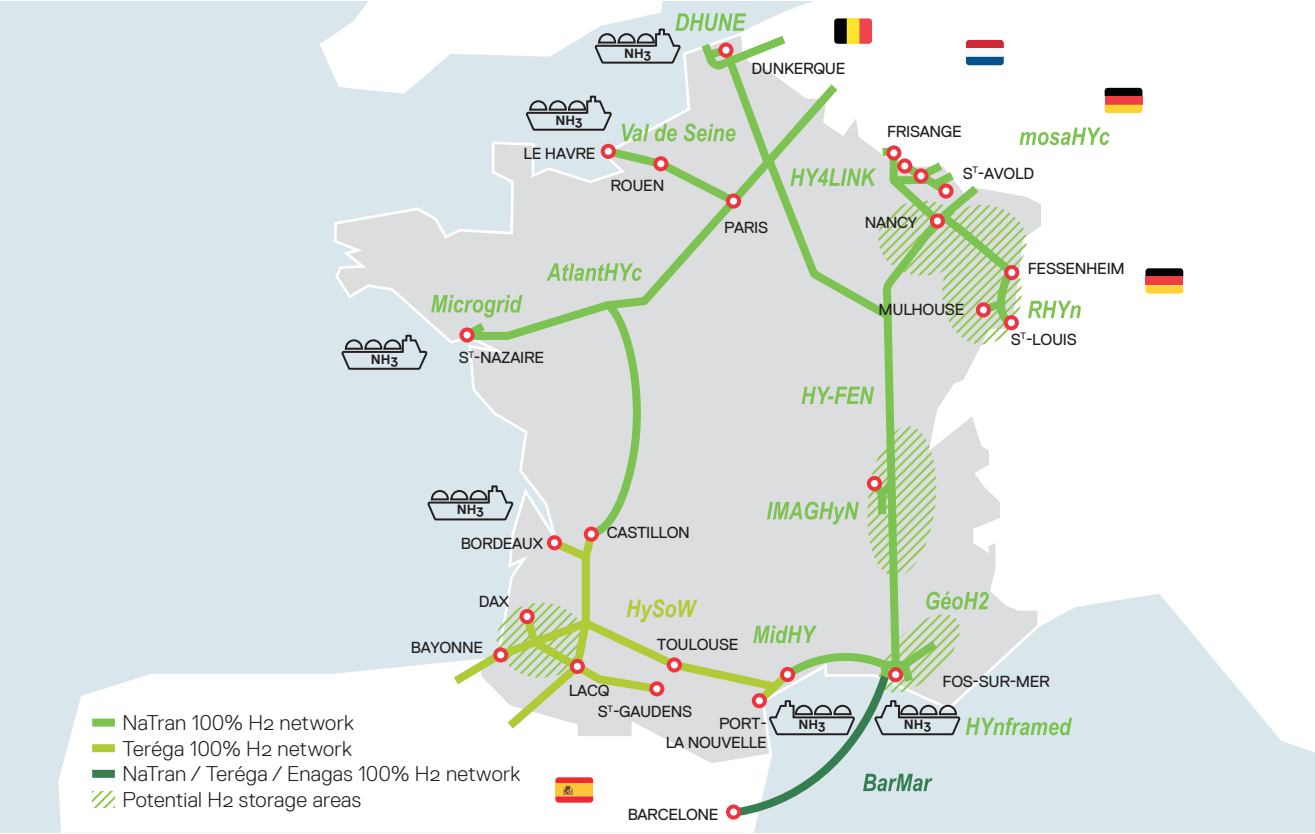
In these ecosystems, with a high density of industrial sites emitting large quantities of greenhouse gases, market players expect transport logistics to connect future production and consumption sites for renewable and low-carbon hydrogen. Beyond these local networks, there is also a need for infrastructure to interconnect these basins with each other and with storage facilities, to guarantee manufacturers access to a decarbonated hydrogen mix under favorable conditions of cost and security of supply.

The South-Western basin stands out for its renewable, low-carbon hydrogen production capacity, which exceeds local demand and provides a link between import flows arriving on the Atlantic coast (Port of Bordeaux) and those from the Mediterranean (Port la Nouvelle), as well as for its significant storage capacity.

As gas transmission experts, NaTran and Teréga are supporting the development of this new market. The priority is to develop a large-scale hydrogen pipeline network to build a competitive and secure organized hydrogen market. The development master plan proposed by the two transport operators aims to provide a coherent, adapted and interconnected service to meet local, national and, by extension, European needs. It is based on the numerous infrastructure projects carried out by NaTran and Teréga, which are co-constructed with the market and anchored in the needs expressed by the future users who will connect to them.

## HYDROGEN TRANSPORT NETWORK FROM 2040

Source: SER, based on NaTran




### THE H2MED PROJECT

The H2med project is a transnational initiative to link the hydrogen networks of the Iberian Peninsula in northwestern Europe, in order to supply the continent with affordable renewable hydrogen by 2030. This initiative, launched by France, Spain and Portugal with the support of Germany, is supported by the transmission system operators of these same countries: NaTran, Teréga, Enagás, REN and OGE.

With a transport capacity of 2 million tonnes of hydrogen per year, the H2med project represents 10% of Europe's estimated hydrogen consumption by 2030, and is therefore a key factor in the development of the European hydrogen market and the achievement of carbon neutrality targets. The project was officially recognized as a Project of Common Interest (PCI) by the European Union in 2024, and has received European funding for development studies under the Connecting Europe Facility (CEF).

The call for expressions of interest at the end of 2024 identified significant production potential in the Iberian Peninsula, as well as consumption areas in France and Germany.

The project is also strategic for France, as it will enable the country to build a robust transport infrastructure that unifies and irrigates the territory at reduced cost, taking advantage of scale effects shared with Iberian productors and German hydrogen consumers. It will give French industry access to a competitive choice of hydrogen sources, while guaranteeing greater security of supply.

▶ To find out more about this project:
**https://h2medproject.com/**

# A FOCUS ON BIOGENIC $CO_2$

**Biogenic CO2, or bioCO2, resulting from the combustion or degradation of biomass (organic matter), is a neutral molecule for climate change, insofar as this carbon is captured by plants during their growth.**

**Currently, this CO2 is a co-product of anaerobic digestion, and tomorrow it will also be thanks to the development of new, complementary low-carbon, renewable gas production processes.** As part of the BECCU (Bioenergy with Carbon Capture and Utilization), its valorization makes it possible:

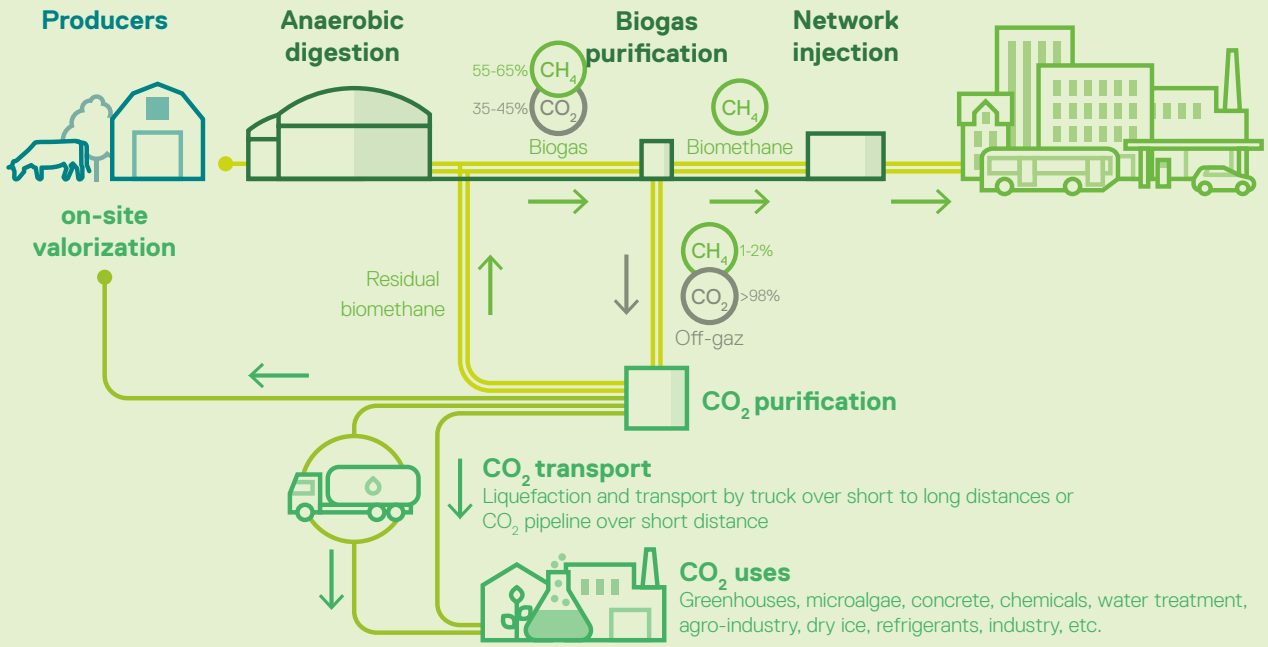
▶ To optimize the use of biomass and maximize the value of renewable and low-carbon gas co-products;

▶ And to accompany the defossilisation of the economy by avoiding new fossil CO2 emissions, either directly in the form of CO2, or indirectly through products such as e-methane or e-fuels. These are known as "avoided emissions".

CO2 sequestration (BECCS - Bioenergy with Carbon Capture and Storage) could even contribute to the removal of CO2 from the atmosphere, as recommended by the IPCC to limit climate change. Indeed, this CO2 is part of the short carbon cycle and was already present in the atmosphere, contributing to the greenhouse effect. By sequestering it permanently, we reduce the level of active greenhouse gases, which is why we speak of "negative emissions".

## $CO_2$ RECOVERY

Source: GRDF




In France, the potential for biogenic CO2 production from anaerobic digestion already exceeds 1.5 million tonnes of CO2/year. The recovery of this potential could cover all the needs of the current national market, estimated at between 500 and 1,000 ktCO2/year. This potential should reach several tens of millions of tonnes by 2050 for all renewable gases. The production of fuels and synthetic molecules seems to be the main market for this renewable CO2.

To coincide with the Pycasso project's application for the European PCI ("Project of Common Interest") label, and following its CEI launched at the end of 2023, Teréga has updated data on the potential for biogenic CO2 emissions in the South-West of France. The latest estimates put this potential at over 3 MtCO2/year by 2035 (out of a total of over 6 MtCO2/year). The region is also home to four biogenic CO2 recovery projects, mainly focused on the production of e-fuels in combination with H2, testifying to the region's real dynamism.

BioCO2 thus represents a new strategic sector due to its potential, its low cost of capture (particularly for anaerobic digestion plants), and its environmental value.

What's more, combining the use of biomethane with the capture of the CO2 (bioCO2) emitted during its combustion offers an effective decarbonization solution for industry.

To be valorized (BECCU) or stored (BECCS), CO2 must be transported from its capture site. There are several ways of recovering bioCO2 from renewable gases:

- In liquid form: after liquefaction, CO2 can be transported by truck, train or ship to the consumption site. Depending on the end use, certification of bioCO2 purity and food quality may be required.

- By pipeline in gaseous or dense form: this method, which reduces the cost of the value chain, is promising. It does, however, require proximity to recovery projects and certain regulatory adjustments currently underway.

- In situ valorisation: bioCO2 can be chemically transformed on site, by combining it with hydrogen to produce e-methane, e-kerosene, etc. However, the absence of a viable business model remains a major obstacle to the development of this sector.

## EXAMPLE OF BIOCO₂ VALORIZATION PROJECTS WINNERS OF GRDF'S CFPs

Since 2021, GRDF has launched several **Calls for Projects (CFP) on the valorization of CO2 from anaerobic digestion.** These calls have identified and supported pioneering projects led by stakeholders involved in the field: developers, biomethane producers, purifiers, consultancies, chambers of agriculture, innovative start-ups and more. There are a wide range of uses: greenhouses, e-molecules, dry ice, breweries, the meat industry, etc.

- For more information:
**GRDF's BioCO2 CFP winners**
https://innovation.grdf.fr/article/58

- For more information:
**BioCO2 CFP in the food industry**
https://innovation.grdf.fr/article/82

## EXAMPLE OF $CO_2$ TRANSPORT PROJECTS

NaTran is developing **projects to transport CO2 by pipeline.** The GO CO2 project, centered on Saint-Nazaire / Montoir-de-Bretagne (400km) and the DKHARBO project on the Dunkirk ZIP (30km). The development of these high-capacity CO2 transport networks paves the way for the implementation of BECCS or biogenic CO2 recovery in France.
In 2023 and 2024, these projects were the subject of market calls for interest and feasibility studies. Basic engineering studies are due to start in 2025. They involve the development of CO2 transport networks between industrial companies capturing their CO2 and terminals for exporting the CO2 by ship or offshore pipeline to permanent geological storage, or to CO2 recovery projects. These networks are also intended to transport biogenic CO2, which may make up part of the emissions captured by certain manufacturers, or directly from anaerobic digestion plants and new renewable gas production facilities connected to this network.

- For more information:
**https://www.natrangroupe.com/notre-transition-energetique/transport-co2**

## A PROJECT COVERING THE ENTIRE CCUS VALUE CHAIN

Teréga is developing the Pycasso project, **a unique project covering the entire CCUS** (Carbon Capture, Utilization and Storage) value chain. The residual CO2 captured can either be valorized by combining it with hydrogen to produce synthetic fuels (e-fuels in particular), or sequestered in suitable geological structures onshore in southwestern France. The identified capture potential amounts to 6MtCO2/year by 2035. Part of this CO2 comes from two sites that rank among France's 50 biggest emitters, with 50% of this CO2 being of biogenic origin, from paper mills for example.

- For more information: **https://www.pycasso-project.eu**

# A FOCUS ON THE 1ST BAROMETER OF RENEWABLE AND LOW-CARBON GAS COMPANIES

**In January 2025, France Gaz, in collaboration with its partners, including the French Renewable Energy Trade Association, the the "New Energy Systems" Strategic Industry Committee (SIC), NaTran, GRDF, the Club Biogaz de l'Association ATEE and Biogaz Vallée®, published the results of the 1st "Barometer of renewable and low-carbon gas companies". This barometer, carried out with the support of Xerfi Specifics and Blunomy, highlights the growth dynamic of companies in this booming sector.**

**For its first edition, this barometer complements the Panorama of Renewable Gas, which focuses more on production.** It highlights players up and down the value chain, in particular manufacturers, prime contractors, equipment suppliers, design offices and developers. These companies form the "2nd circle" of the barometer's infographic, reflecting their contribution to the industry's economic activity.

## REPRESENTATION OF THE "RENEWABLE GASES" ECOSYSTEM AND THE BAROMETER'S TARGET PERIMETER


**1st circle**
Renewable gas production (i.e. unit operation) is at the heart of the operation of these sectors. A number of publications already enable us to track the development of production capacity (e.g. Biomethane Industry Observatory, Panorama of renewable gas, etc.). The first edition of the barometer therefore did not focus on gas production and sales players.

**2nd circle**
The first edition of the barometer focused on highlighting a base of local companies in direct contact with production players, both upstream and downstream: manufacturers, equipment suppliers, maintenance, design offices, network operators, etc.

**3rd circle**
For this first edition, activities further away from production for which the stakeholders are not very specialized in renewable gases (financiers, prescribers, training centers) were not targeted as a priority.

The key findings of the "Barometer of Renewable and Low-Carbon Gas Companies" show that the energy transition is generating wealth, boosting industrial employment and stimulating innovation in local areas. Overall, the renewable gas sector stands out for its dynamism and territorial roots, with a strong presence in small towns. Business and sales are growing steadily, with favorable prospects for the years ahead.

Production remains predominantly French, in terms of both added value and equipment. The sector's expansion is accompanied by the creation of new industrial jobs, particularly skilled ones. Innovation is a key driver of development, as evidenced by the number of patents filed and R&D investments. Last but not least, the sector's international reach is growing, with a strong presence in Europe and North America.


▶ Find out more about the study here:
**https://www.francegaz.fr/wp-content/uploads/250127_Synthese-du-barometre-des-gaz-renouvelables_vSent.pdf**


# THE PANORAMA OF RENEWABLE GAS CELEBRATES ITS 10TH ANNIVERSARY!

**On this occasion, all our partners would like to thank all those who have contributed to its development and continuity since 2015:**

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