RENEWABLE GAS
FRENCH PANORAMA
2019

GRDF GAZ RÉSEAU DISTRIBUTION FRANCE

GRTgaz

SPEGNN

ser Syndicat des énergies renouvelables

TERÉGA

Forward

The French industry of biomethane production and injection into the natural gas network has been booming for more than five years, and there are many encouraging signs for the development of a strong French industrial anaerobic digestion sector:

- Emmanuelle WARGON, Minister of State to the Minister for the Ecological and Inclusive Transition, continued in 2019 to lead the National Anaerobic Digestion Working Group launched in 2018 by Minister of State, Sébastien LECORNU, and which identified 16 priority work areas benefiting anaerobic digestion;
- Continuation of the work of the "New Energy Systems" Industry Strategic Committee created at the end of 2018, including a sectoral contract between the anaerobic digestion sector and the State;
- Publication in May 2019 of texts governing support for biomethane initially provided for by the Mobility Guidance Act (LOM);
- Publication in June 2019 of texts governing the principle of the right to injection established by the Law for the Balance of Trade Relations in the Agricultural Sector and Healthy and Sustainable Food of 2018 (EGALIM Law);
- And more recently, the creation of the Eiffel Gaz Vert investment fund.

2019 was also marked by ongoing work on the revision of the Multiannual Energy Programme (PPE). Stakeholders in the anaerobic digestion sector, the first renewable gas production chain to date, have fully mobilised to protect the leading role of renewable gases in France's energy mix. This mix will have to respond to the climate emergency, and will enable France to successfully make its energy transition towards carbon neutrality. Stakeholders have hence called for the implementation of a predictable and sustainable economic framework, with objectives that are consistent with the sector's actual development and cost-cutting capacities.

The PPE, published in April 2020, is disappointing in this context, as it remains disconnected from the growth observed on the ground by setting objectives that are too low: 6 TWh[1] in 2023, which represents a rollback of 2 TWh compared to the previous PPE, and 14-22 TWh in 2028. This will not meet the goal of the Energy Transition for Green Growth Act of 2015 to reach 10% of renewable gas consumption in 2030. The PPE also anticipates a cost reduction path that is too drastic for future projects and likely to jeopardise the sector's development.

In addition, all stakeholders are involved in future work, and are already committed to other elements of the economic framework (future auctioning of guarantees of origin, work to define the new price for injection in an "open window", implementation of the first calls for tender, and end of the TICGN (tax on the consumption of natural gas) exemption for injected biomethane provided for in the 2020 Finance Act).

To reflect the growth of the sector, GRDF, GRTgaz, SPEGNN, SER and TEREGA are continuing their cooperation and publishing a detailed inventory of biomethane injection at regional, national and European levels for the fifth consecutive year.

→ THE 5TH EDITION ON RENEWABLE GAS BEING INJECTED INTO THE FRENCH NATURAL GAS NETWORK

The 5th edition of the "Renewable Gas French Panorama" is an update of data from network operators registered in France[2] by 31 December 2019. This annual publication presents sector indicators in the form of infographics. All the information is compared with the French ambitions for renewable gas production in the years to come. This overview includes news on the sector, economic and regulatory aspects, a European element and the presentation of biomethane injection projects.

1. 1 TWh = 1,000 GWh = 1,000,000 MWh = 1,000,000,000 kWh = equivalent to the average consumption of 80,000 households.
2. To date, there are no biomethane injection projects in the French overseas territories or Corsica. (Source: network operators)

→ RENEWABLE GAS INJECTION EXCEEDS ONE TWh OF ACTUAL PRODUCTION IN THE FRENCH NATURAL GAS NETWORK

In 2019, the installed facilities exceeded the symbolic threshold of 1 TWh of actual production injected into the French natural gas network, reaching 1.2 TWh at the end of 2019, compared with 0.71 TWh at the end of 2018. The maximum annual injection capacity reached 2.1 TWh at the end of 2019, compared with 1.2 TWh at the end of 2018. The difference between the quantities injected and the maximum installed capacity comes almost exclusively from the limited operating time and the ramp-up of the installations that were commissioned throughout the year. The current trend results from the investment and collaboration of all industry stakeholders, in particular within the "biomethane injection" working group (WG) led by ADEME and GRDF and its various sub-WGs (support mechanisms, financing, network adaptation, etc.). Renewable gas professionals are continuing their efforts to generate and complete an increasing number of projects, and develop new innovative renewable gas production sectors (pyro-gasification, hydrothermal gasification, Power-to-Gas, etc.)

→ RENEWABLE GASES ARE IN THE HEART OF REGIONS

While renewable gases have the advantage of being able to respond to three energy market opportunities (electricity, heat and fuel), the sector still has other advantages. It is part of the circular, agricultural and local economy, with many positive externalities, including the local recovery of waste, its contribution to the resilience of the agricultural and agro-food network, the decarbonisation of the energy and agricultural sectors, the return of digestate soil as natural fertiliser, the creation of local jobs, and as a source of innovation (pyro-gasification, Power-to-Gas, transported gas, anaerobic digestion of algae, etc.). Renewable gas contributes to energy independence with the sustainable production of renewable energy that can be stored in the networks and produced near consumption areas. One of the levers for reducing production costs is the fair remuneration of each service provided. The skill enhancement of all actors in the value chain, and the structuring and progressive professionalisation of the sector made it possible to reach 4,000 direct and indirect biogas sector jobs in 2018, with a turnover of 695 million euros[3]. The biomethane sector can create on average 3-4 local jobs per installation that cannot be relocated, solely within operations and maintenance[4].

3. Based on the adaptation of the "Ecological Transition, Regions, Jobs" (TETE) tool developed by the Action Climat France network and ADEME with the contribution of Philippe Quirion, January 2018 (https://territoires-emplois.org).
   Turnover includes investments, operations and maintenance of anaerobic digestion units.
4. Study of the impact of the biogas sector on employment in France from 2018 to 2030, July 2019, In numeri, Smash

→ THE MESSAGE FROM OPERATORS OF DISTRIBUTION AND TRANSPORT NETWORKS

With the Climate Energy Act enacted in 2019, France has declared a state of climate and ecological emergency. In this context, biomethane production will contribute to the national effort to reduce greenhouse gases. This Act also reaffirmed the goal of making renewable gas 10% of total gas consumption by 2030, and the regions are mobilising to develop biomethane with initiatives including the Breton biogas pact, West Grid Synergy (smart gas network), the anaerobic digestion action plan for the Grand-Est region, the Ardennes pact, and many others.

Thanks to its multiplicity of uses and the presence of a national network of infrastructures developed over a large part of the country, the sector offers a response to climate challenges and social or economic problems, while generating numerous services for the regions. The benefits provided by biomethane can represent up to €70/MWh of value creation for the community, according to data from the Prospective Committee of the Energy Regulatory Commission (CRE) as part of its prospective work[5].

The benefits are manifold:

- **Renewable energy production to meet greenhouse gas reduction targets:**
  - → The biomethane life cycle analysis (LCA)[6] estimates that CO_2 emissions are one-tenth of those of natural gas for each megawatt hour (MWh) of biomethane produced, injected and consumed for heat purposes.
  - → In transport: Bio-NGV results in nearly 80% less greenhouse gas emissions compared to diesel.

- **Support for regional development and the circular economy:**
  - → The local and non-relocatable production of biomethane is a lever for developing the circular economy (energy recovery of locally co-produced waste) and a means of boosting local employment, with an average of 3 to 4 jobs per site in operations and maintenance[7].
  - → The resources are mainly located in rural agricultural areas, while gas consumption is concentrated in large urban centres. Local production thus restores local solidarity between the cities and the countryside.
  - → At a time when the agricultural world is experiencing difficulties, biomethane production allows for farming activities to be sustained while responding to the problem of managing their co-products and contributing to the development of sustainable agriculture geared towards the bioeconomy.

Despite these advantages, the development of biomethane, like many other renewable energies, faces short-term competition from fossil fuels. This is why the sector has embarked on an ambitious roadmap to gradually reduce its production costs and become economically competitive.

With a more ambitious biomethane development policy based on a varied energy mix, France has a solution at its disposal to meet the current challenges of reducing greenhouse gases, improving air quality, and revitalising the regions. This proactive strategy must be based on:

- Maintaining tax support for the use of biomethane under an environmental tax system;
- Maintaining a “fair pay” mechanism for biomethane producers, co-constructed with sector stakeholders;
- Launching trials aimed at implementing complementary financing solutions for the sector;
- A regulatory framework facilitating the implementation of projects and supporting the current trend.

Under the new right to injection, network operators are currently working towards making the necessary adaptations and strengthening measures to allow the injection of biomethane into the gas network. They will continue to help accelerate this growth in order to address the increasingly important climate, social and economic challenges.

5. Gas Greening Report, CRE Prospective Committee, 2019
6. Assessment of the GHG impacts of injecting biomethane into gas networks”, Enea-Quantis, 2017
7. Study of the impact of the biogas sector on employment in France from 2018 to 2030, July 2019, In numeri, Smash

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1. Biomethane: an essential renewable gas

1.1. From biogas production to biomethane injection: a solution for reducing greenhouse gas emissions in the future

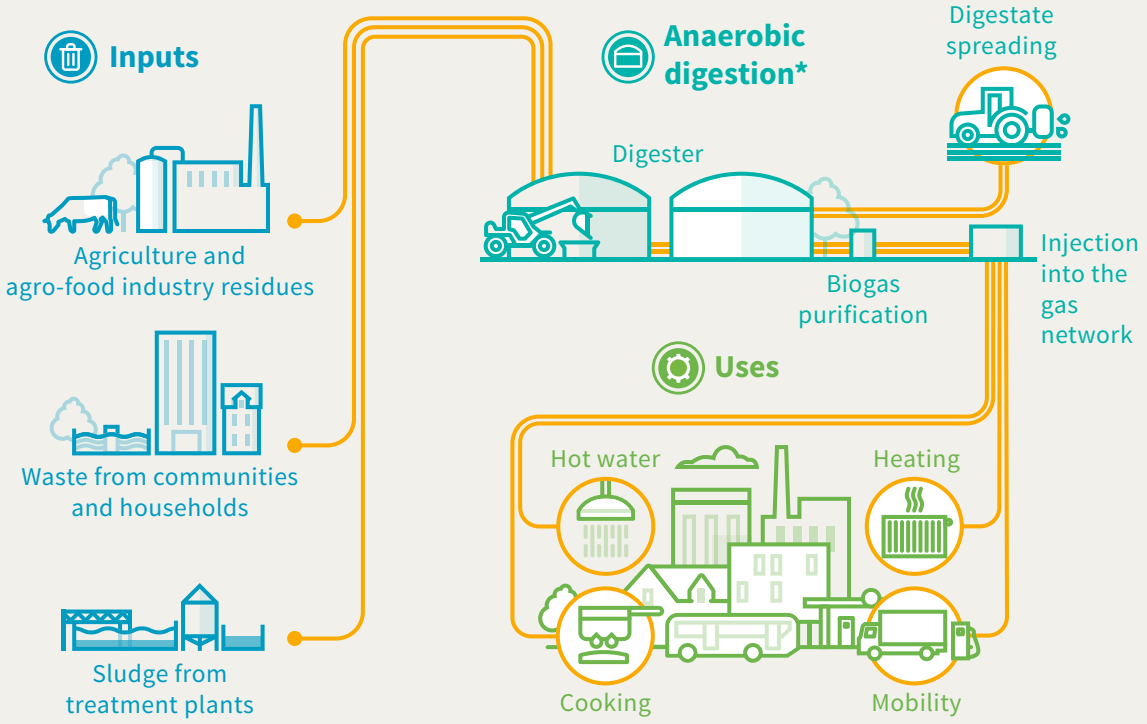
The controlled production of biogas is called anaerobic digestion. It is a process of animal and/or plant organic matter being decomposed by micro-organisms. It produces a gaseous mixture that is saturated with water and made up of 50 to 65% methane. Organic matter can come from various sectors: agricultural, industrial, catering waste, community waste, gas from storage facilities for non-hazardous waste (SFNHW)[8], etc. Once collected and transported to the anaerobic digestion site, the organic matter is sorted, stirred and heated for a few weeks in a digester (oxygen-free enclosure). This organic matter anaerobic digestion process produces biogas that can be recovered by combustion in the form of heat and/or electricity. This biogas can also be purified to attain the same quality as natural gas. It is then called "biomethane" or "biomethane fuel" / "Bio-NGV" when it is intended to supply vehicles. Regardless of the production process used, this purification step is essential to remove impurities and undesirable components from biogas, i.e. carbon dioxide, sulphur compounds and water. Once purified and odorised, biomethane can be injected into the natural gas network.

Anaerobic digestion has not only the added value of producing a renewable energy or fuel but also of providing an alternative process for treating organic waste. By collecting this waste to produce biomethane, their environmental impact is reduced by avoiding greenhouse gas (GHG) atmospheric emissions and by increasing their energy potential. Biogas production also produces a co-product called digestate. This is a natural organic fertiliser that can be applied to agricultural land and therefore used as a substitute for mineral fertilisers of fossil origin.

Given all these advantages, biogas production has been part of the renewable energy development strategy in France since 2011. The Energy Transition Act for Green Growth (LTECV) reinforces the ambitions attributed to the biomethane injection sector. The prospective committee of the Energy Regulatory Commission (CRE) concluded that "given the country's available resources, the objective of production equal to 10% of total gas consumption in 2030 is realistic, i.e. production of 39 to 42 TWh of biomethane"[9].

8. Gas produced in landfills, mainly resulting from the anaerobic degradation of biodegradable organic matter.
9. CRE - Gas Greening Report - July 2019.

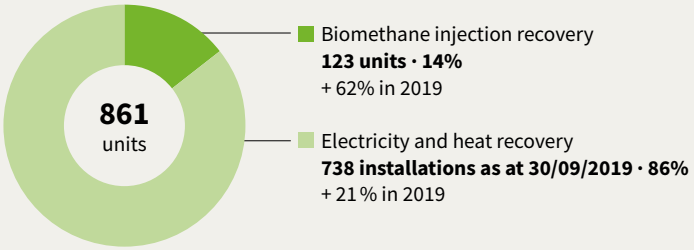
From anaerobic digestion to injection: key stages
Source: GRDF



* Decomposition of the fermentable part of the inputs, in the absence of oxygen, to produce biogas.

Renewable gas production units by valuation in France (2019)
Source: Network Operators, December 2019 & MTES Dashboard at 30 September 2019

At the end of 2019, France had more than 860 biogas production units, 123 of which recover it in the form of biomethane injected into natural gas networks. The strong growth in 2018 was further amplified in 2019: + 73% injected volume.



1.2. Typology of biomethane injection sites and classes of inputs used for their supply

→ TYPOLOGY OF BIOMETHANE INJECTION SITES

© Denis Fourquet

▶ AUTONOMOUS AGRICULTURE

- carried out by one or more farmers or by a structure mostly owned by one or more farmers
- carrying out anaerobic digestion of more than 90% of agricultural materials from agricultural operations

© Aurélien Mahot

▶ TERRITORIAL AGRICULTURAL

- carried out by a farmer, a collective of farmers or by a structure mostly owned by one or more farmers
- carrying out anaerobic digestion of more than 50% (by mass) of materials from the agricultural operations
- including waste from the region (industry, treatment plants, etc.)

© Pascal Léopold

▶ REGIONAL INDUSTRY

- carried out by a project developer or one or more industrialists
- including waste from the region (industry, treatment plants, etc.)
- carrying out anaerobic digestion of agricultural and non-agricultural operations

© Daniel Lheritier

▶ HOUSEHOLD WASTE AND BIOWASTE

- carried out by a community, an agglomeration, a waste treatment trade union, one or more industrialist(s)
- carrying out anaerobic digestion of the organic part of household waste, sorted in the factory or collected separately, treating bio-waste

© CCPR

▶ SEWAGE SLUDGE

- urban and industrial

© S. Cuisset

▶ STORAGE FACILITIES FOR NON-HAZARDOUS WASTE (SFNHW)

→ VARIOUS CLASSES OF INPUTS USED TO PRODUCE BIOMETHANE

▶ LIVESTOCK EFFLUENTS (SLURRY, MANURE)

Slurry (liquid and solid animal excrement) and manure (mixing manure with animal litter: straw, hay, etc.) account for the majority of the effluent. Livestock effluents are produced by livestock business, in particular cattle and pigs, and are located in livestock buildings.

▶ CROP RESIDUE

Agricultural waste from crops (e.g. corn stover).

▶ SEQUENTIAL CROPS / CATCH CROPS

A sequential crop is a crop planted and harvested between two main crops in a crop rotation. Intermediate energy crops can be harvested for use as an input to an agricultural anaerobic-digestion unit.
A catch crop is a temporary crop of fast-growing plants used to protect plots between two main crops. Covers are mandatory in some regions or areas because of nitrate pollution. By using them for their growth, cover crops trap the remaining nitrates at the end of the previous main crop.

▶ ENERGY CROPS[10]

These are crops grown primarily to produce energy. They can be used as inputs in anaerobic digestion units that will use the energy power of these plants, within a framework defined by regulations.

▶ AGRO-FOOD INDUSTRY SLUDGE AND CO-PRODUCTS

Agro-food industries generate numerous co-products during the technological processes they use to develop finished products (dairy products, meat, grain products, fruit and vegetables, etc.). Once the product is valued, it will be called a “co-product”. Agro-industrial sludge emerges from slaughterhouses, dairies, cheese factories, biscuit factories, breweries, canneries, etc.

▶ ANIMAL BY-PRODUCTS (ABP)

European Regulation (EC) No 1069/2009 classifies 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 hygiene levels.

▶ HOUSEHOLD WASTE

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

▶ GREEN WASTE

Green waste (GW) refers to vegetable waste resulting from maintaining and renewing public and private green spaces (parks and gardens, sports fields, etc.), from local authorities, public and parapublic organisations, private companies and individuals.

▶ OTHER (SLUDGE FROM TREATMENT PLANTS, ETC.)

Sludge treated in wastewater treatment plants is the result of human activity. Its use in biomethane production has been authorised since 2014.

10. Decree No. 2016-929 of 7 July 2016 sets maximum supply thresholds for anaerobic digestion facilities. Non-hazardous waste or raw-material anaerobic digestion installations can be supplied by food crops (cereals and other plants that are rich in starch, sugar, oilseeds, legumes, for either human or animal consumption) or energy crops grown especially, up to a maximum 15% of the total gross tonnage of inputs per calendar year. These input thresholds are calculated over three rolling years.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2. Biomethane injection - key figures and facilities in France

2.1. Production facilities for the biomethane injection sector as of 31 December 2019

2,157 GWh/year **biomethane-connected facilities** + 79% in 2019

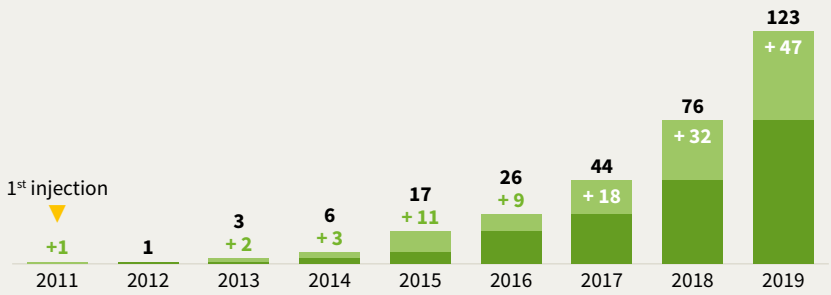
123 biomethane injection sites + 62% in 2019

1,235 GWh **renewable production**[11] + 73% in 2019

0.26% of **natural gas consumption** + 69% in 2019

- Biomethane injection sites injected 1,235 GWh into natural gas networks (+73% in one year).
- The share of biomethane in the national natural gas consumption increased by 69% compared with 2018, which is the equivalent of around 103,000 homes or 5,500 lorries/buses.
- Production equipment increased by 62% in one year.

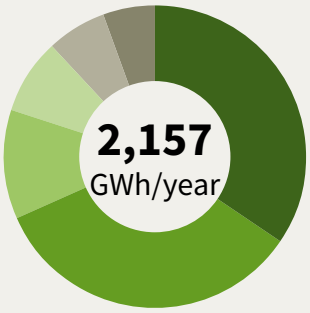
Total number of sites in service and annual change
Source: Network Operators



11. Energy injected into the natural gas network in 2019.

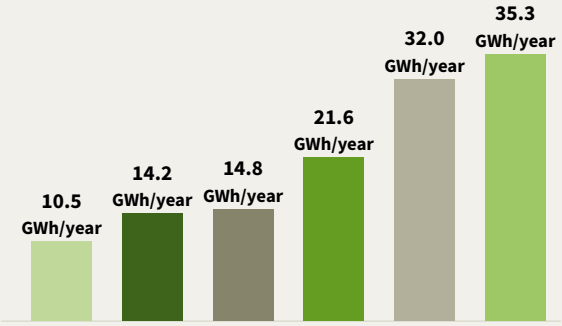
2.2. Characteristics of the connected fleet

Distribution of the total installed maximum capacity[12] per type of injection site as of 31 December 2019
Source: Network Operators



- Autonomous agriculture
  53 sites · 752 GWh/year · 35%
- Territorial agricultural
  34 sites · 733 GWh/year · 34 %
- Territorial industry
  7 sites · 247 GWh/year · 11 %
- Sewage sludge
  17 sites · 179 GWh/year · 8 %
- Household waste and biowaste
  4 sites · 128 GWh/year · 6 %
- Storage facilities for non-hazardous waste (SFNHW)
  8 sites · 118 GWh/year · 5 %

Average size of biomethane injection facilities according to the nature of the facility, expressed in maximum production capacity[12].
Source: Network Operators



- Sewage sludge
- Autonomous agriculture
- Storage facilities for non-hazardous waste (SFNHW)
- Territorial agricultural
- Household waste and biowaste
- Territorial industry

© Thierry Duqueroix / GRTgaz

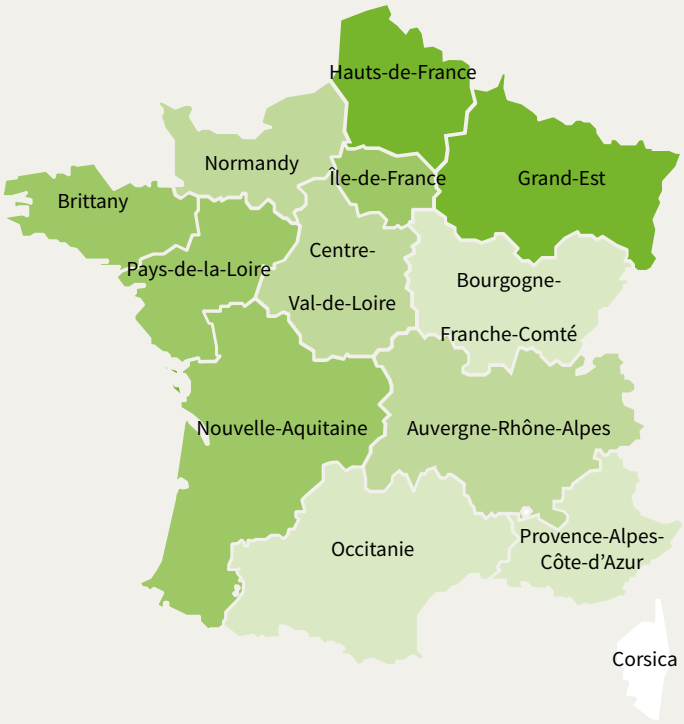
12. The maximum production capacity expressed in TWh/year was calculated based on the following assumptions: maximum capacity, Cmax, extracted from the capacity register expressed in $m^3(n)/h$, HHV = 10.9 $kWh/m^3(n)$ and 8,200 hours of annual operation.

2.3. Regional distribution of facilities

Regional distribution of the maximum capacity[13] installed per rate band as at 31 December 2019
Source: Network Operators

Hauts-de-France	341 GWh/year
Grand-Est	331 GWh/year
Nouvelle-Aquitaine	273 GWh/year
Pays-de-la-Loire	225 GWh/year
Brittany	221 GWh/year
Île-de-France	216 GWh/year
Centre-Val-de-Loire	185 GWh/year
Auvergne-Rhône-Alpes	119 GWh/year
Normandy	105 GWh/year
Bourgogne-Franche-Comté	76 GWh/year
Provence-Alpes-Côte-d'Azur	35 GWh/year
Occitanie	32 GWh/year
Corsica	0 GWh/year

- > 300 GWh/year
  > 27.6 million Nm³/year
- 200 - 300 GWh/year
  18.4 - 27.6 million Nm³/year
- 100 - 200 GWh/year
  9.2 - 18.4 million Nm³/year
- 1 - 100 GWh/year
  1 - 9.2 million Nm³/year
- 0

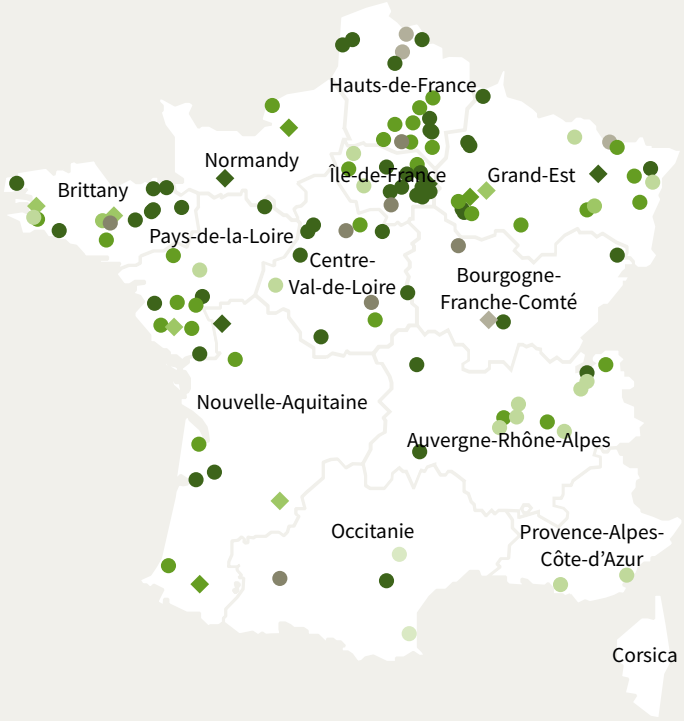


Regional distribution of biomethane injection sites as at 31 December 2019
Source: Network Operators

Grand-Est	20 sites
Hauts-de-France	17 sites
Brittany	16 sites
Île-de-France	15 sites
Auvergne-Rhône-Alpes	12 sites
Centre-Val-de-Loire	11 sites
Pays-de-la-Loire	11 sites
Nouvelle-Aquitaine	8 sites
Bourgogne-Franche-Comté	4 sites
Occitanie	4 sites
Normandy	3 sites
Provence-Alpes-Côte-d'Azur	2 sites
Corsica	0 sites

- Territorial agricultural
- Household waste and biowaste
- Autonomous agriculture
- Sewage sludge
- Territorial industry
- Storage facilities for non-hazardous waste (SFNHW)

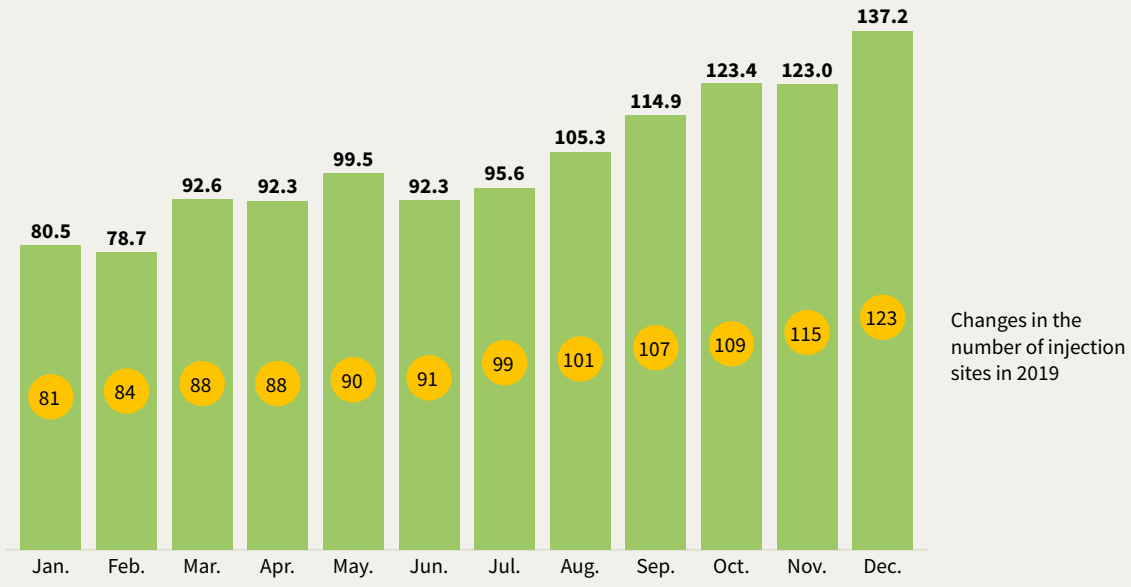
- ● Distribution Network Operators (DSO)
- ◆ Transport Network Operators (TSO)



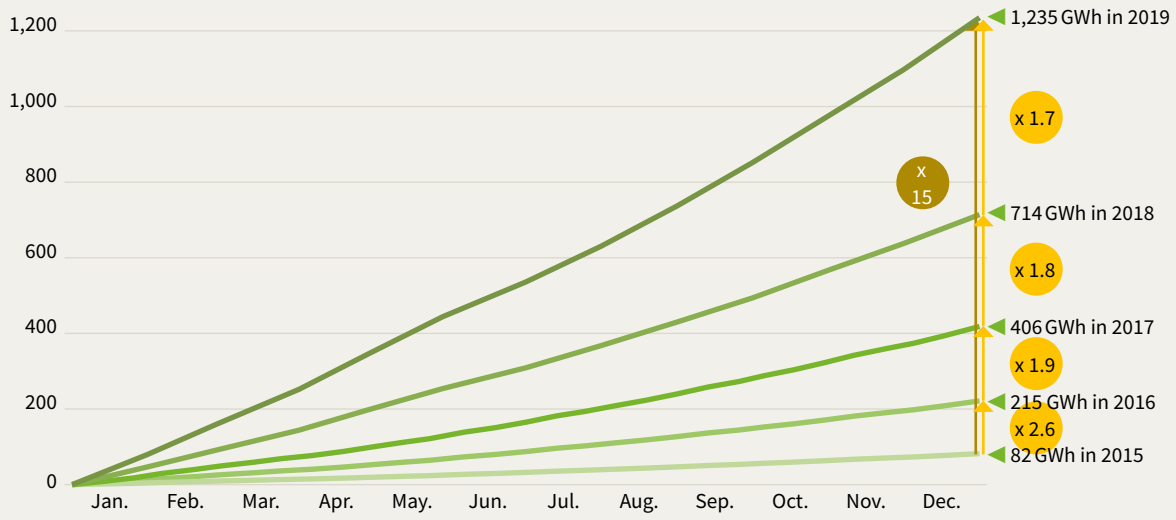
13. The maximum production capacity expressed in TWh/year was calculated based on the following assumptions: maximum capacity, Cmax, extracted from the capacity register expressed in m³(n)/h, HHV = 10.9 kWh/m³(n) and 8,200 hours of annual operation.

2.4. Production of facilities

Monthly production of biomethane injection installations for 2019 (GWh)
Source: Network Operators

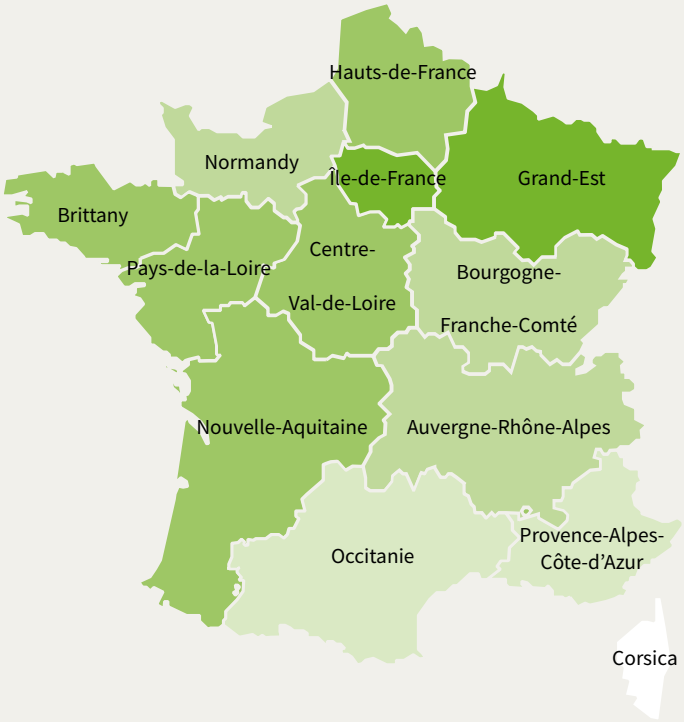


Cumulative production of existing installations in GWh (0°)
Source: Network Operators



Regional distribution of renewable gas production in 2019
Source: Network Operators

Grand-Est	220 GWh/year
Île-de-France	209 GWh/year
Hauts-de-France	124 GWh/year
Brittany	122 GWh/year
Nouvelle-Aquitaine	120 GWh/year
Pays-de-la-Loire	113 GWh/year
Centre-Val-de-Loire	107 GWh/year
Auvergne-Rhône-Alpes	68 GWh/year
Bourgogne-Franche-Comté	56 GWh/year
Normandy	54 GWh/year
Provence-Alpes-Côte-d'Azur	23 GWh/year
Occitanie	21 GWh/year
Corsica	0 GWh/year



- > 150 GWh/year
  > 13.8 million Nm³/year
- 100 - 150 GWh/year
  9.2 - 13.8 million Nm³/year
- 50 - 100 GWh/year
  4.6 - 9.2 million Nm³/year
- 1 - 50 GWh/year
  1 - 4.6 million Nm³/year
- 0

2.5. Injection capacity reservations at 31 December 2019[14]

As part of managing biomethane injection capacities, it was decided to create a registry for transmission and distribution system operators in order to manage capacity reservations and monitor the progress of projects from their study phase through to production. To anticipate the possible saturation of natural gas networks into which the production will be injected, it is necessary to define priority rules that will apply when several projects want to connect to the same zone and are "competing" to obtain the zone's injection capacity. This allows projects to enter according to their order of arrival with a number allocation, which will allow, if necessary, allocations of injection capacity to be prioritised.

24 TWh/year
in the register
+ 71% in 2019

1,085
projects in the register

The 123 installations commissioned at the end of 2019 are included in the registry data. A project is included in the injection capacity management register when it reaches the Phase II study order: feasibility studies for transport networks (TSO) and detailed studies for distribution networks (DSO). At this stage, a project will take 2 to 5 years to complete. GRTgaz and Teréga have been appointed as managers of the capacity management registry by decision of the Energy Regulatory Commission (CRE) dated April 2014.

The maximum cumulative capacity of the 1,085 projects registered in the capacity register amounts to 24 TWh/year, i.e. 10 TWh more than at the end of 2018. This corresponds to the average annual consumption of 106,000 buses or lorries running on Bio-NGV or 3.6 million new gas-heated housing units.

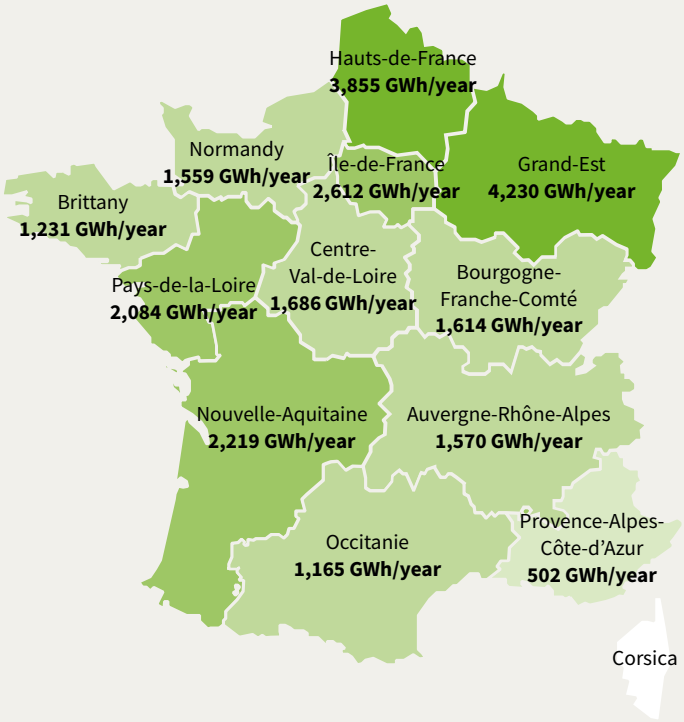
14. Source: http://www.grtgaz.com/solutions-avenir/grtgaz-solutions-davenir-pour-la-transition-energetique/le-biomethane-gaz-renouvelables/donnees-biomethane.html

Regional distribution of maximum capacity[15] of queued biomethane injection projects as of 31 December 2019

Source: GRTgaz and Teréga

Grand-Est	169 projects
Hauts-de-France	147 projects
Brittany	110 projects
Île-de-France	108 projects
Auvergne-Rhône-Alpes	104 projects
Nouvelle-Aquitaine	95 projects
Centre-Val-de-Loire	84 projects
Pays-de-la-Loire	80 projects
Normandy	80 projects
Bourgogne-Franche-Comté	47 projects
Occitanie	42 projects
Provence-Alpes-Côte-d'Azur	19 projects
Corsica	0 projects

- > 3,000 GWh/year
  > 276 million Nm³/year
- 2,000 - 3,000 GWh/year
  184 - 276 million Nm³/year
- 1,000 - 2,000 GWh/year
  92 - 184 million Nm³/year
- 1 - 1,000 GWh/year
  1 - 92 million Nm³/year
- 0



Number of projects by network type as of 31 December 2019

Source: GRTgaz and Teréga

Distribution	**85 %**
Transmission	**15%**

Capacity reserved for production by network type as of 31 December 2019

Source: GRTgaz and Teréga

Distribution	**74 %**
Transmission	**26 %**

15. The maximum production capacity expressed in TWh/year was calculated based on the following assumptions: maximum capacity, Cmax, extracted from the capacity register expressed in m³(n)/h, HHV = 10.9 kWh/m³(n) and 8,200 hours of annual operation.

2.6. Mapping biomethane injection in Europe

Overview of biomethane injection in Europe

Source: Biomethane Observatory December 2019 SIA PARTNERS - FRANCE BIOMETHANE

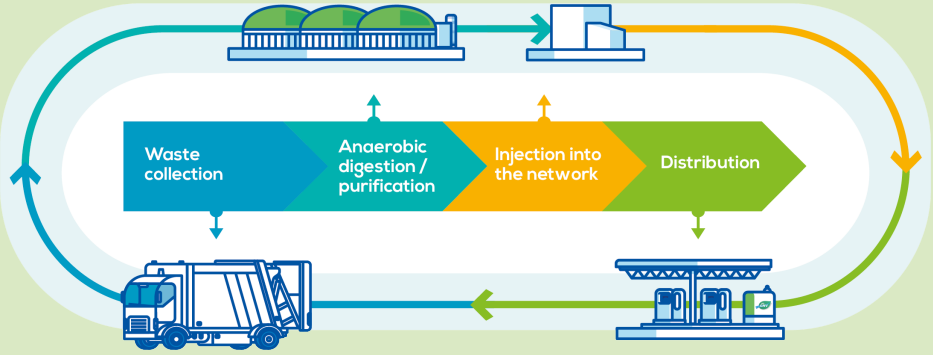
Injection in Europe is continuing its growth with nearly 110 new facilities in 2019, bringing the total number of facilities in service to around 660 for a maximum installed capacity of 570,000 Nm³/h, or 22 TWh of annual biomethane.

FOCUS ON MOBILITY

NGV (Natural Gas Vehicle) and Bio-NGV

NGV is natural gas used as fuel. This is the same gas that is used for heating or cooking. Bio-NGV is biomethane used as fuel. France has become one of Europe's most dynamic markets in this segment. 15 years after the arrival of NGV and Bio-NGV buses, today over 12% of the fleet runs on gas.

The number of stations is increasing in order to supply the French fleet. The use of Bio-NGV in these stations is also supported by national initiatives: the Mobility Guidance Act deals in particular with the establishment of a legislative framework for biomethane consumed directly in Bio-NGV stations.

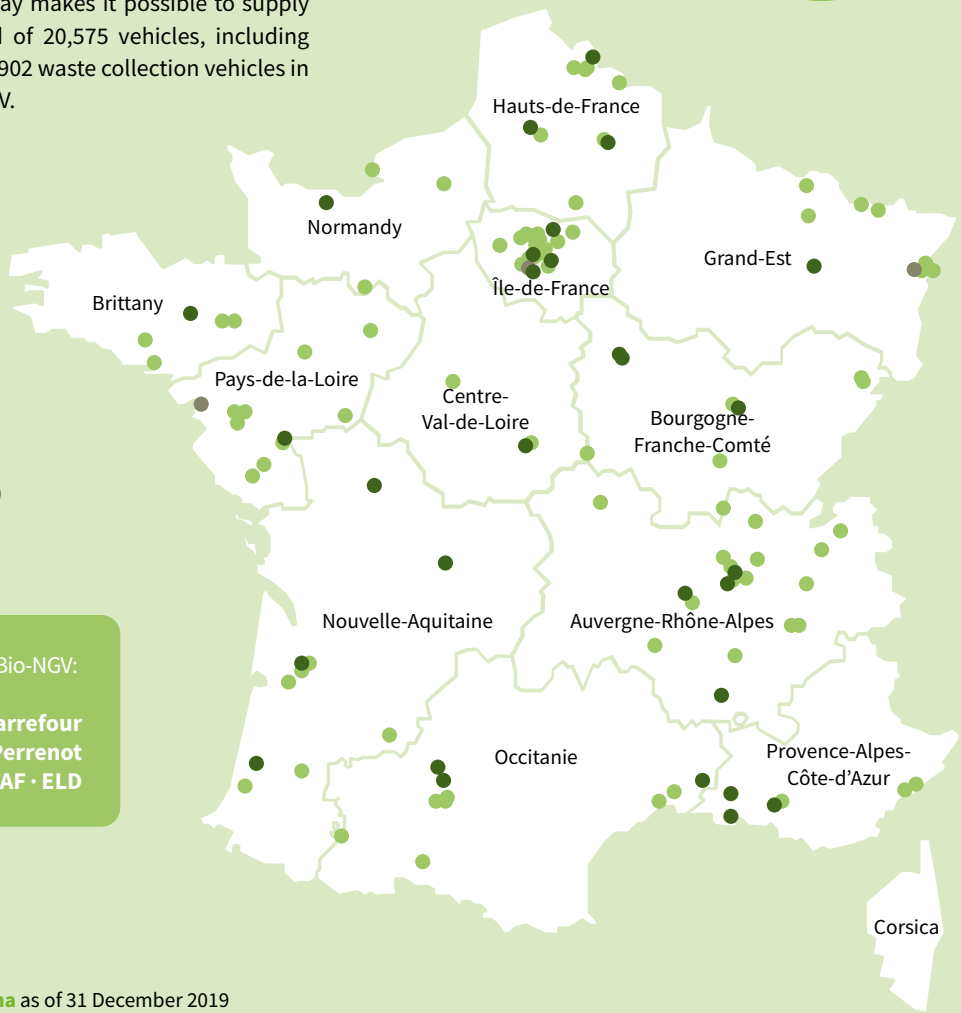


Bio-NGV
- 82 % CO_2
compared to diesel

250 GWh of Bio-NGV
consumed in 2019

Inventories of public NGV stations in France on 30.11.2019
Source: https://gnv-grtgaz.opendatasoft.com/pages/dashboard_v3/

The offer of NGV stations today makes it possible to supply the French fleet - composed of 20,575 vehicles, including 3,513 HGV, 3,390 buses and 1,902 waste collection vehicles in November 2019 - with Bio-NGV.



NGV fuel / Bio-NGV:

- Compressed Natural Gas (CNG)
- Liquefied Natural Gas (LNG)
- LNG, CNG

The following have chosen Bio-NGV:

RATP · City of Paris · Carrefour Monoprix · Ecolotrans · Perrenot Lidl · Peixoto · Jardel · STAF · ELD

3. Regulatory framework

Significant targets have been set by France and the European Union for reducing greenhouse gas emissions, energy efficiency and developing the share of renewable energies in total energy consumption. Biomethane injected into gas networks is already helping to achieve these objectives.

In 2010, the National Action Plan (NAP) for renewable energy laid the foundations for a new purchasing obligation for biomethane injected into natural gas networks, which is similar to that which was established for electricity. In November 2011, the 8 Decrees and Orders allowing the biomethane injection channel to be developed in networks were published. They were incorporated into the French Energy Code.

In 2018, the Renewable Energy Directive II (RED II) was passed. The text, which must be transposed into French law by 30 June 2021, contains provisions relating to the biomethane sector.

The biomethane sector therefore benefits from two economic tools:

- a regulated and guaranteed purchase price for 15 years for producers;
- a guarantees of origin system, which ensures biomethane can be traced and accentuates its value for consumers as part of a green offer.

3.1. Introduction of a feed-in tariff for biomethane injected into natural gas networks

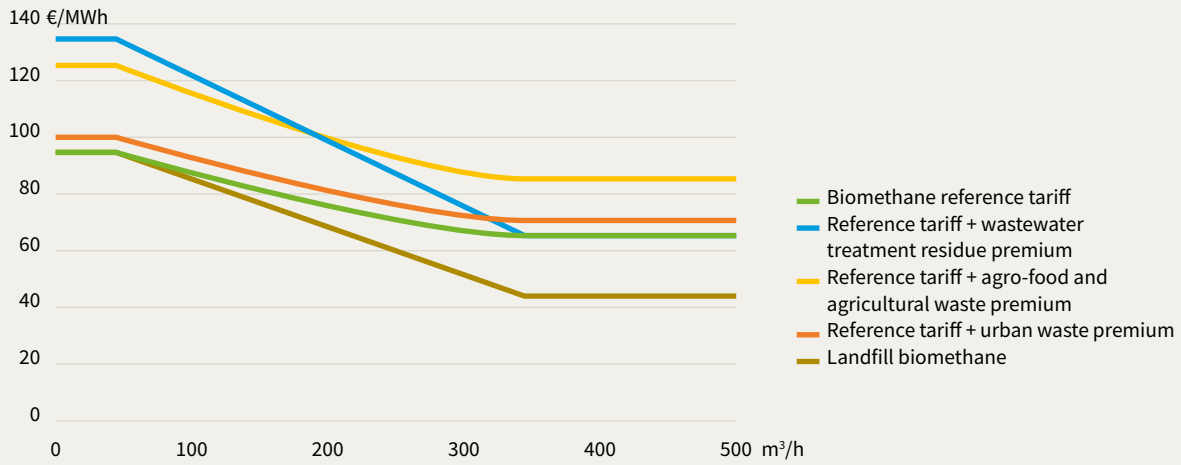
Thanks to this system, a producer is guaranteed to sell the biomethane produced by its installation to a natural gas supplier at a rate fixed by Decree for a period of 15 years.

The producer will benefit from a purchase price of between €46 and €139/MWh, for an average price of €95/MWh. The price depends on the production facility's size, referred to as the maximum capacity of biomethane production (expressed in Nm^3/h) and the nature of the waste or organic matter being treated. For anaerobic digestion facilities, purchase prices are made up of a reference tariff and an intrant premium.

According to Decree No. 2016-411 of 7 April 2016 on the various adaptation measures in the gas sector, the State may use tenders in addition to feed-in tariffs to support the biomethane injection sector.

The Decree contains stipulations governing the terms and conditions of these tenders, the terms of which are currently being defined by the Ministry for the Ecological and Inclusion Transition.

Biomethane feed-in tariff according to the type of waste and the installation's maximum production capacity of biomethane



- The reference tariff is:
  → between €45 and €95/MWh for storage facilities for non-hazardous waste;
  → between €64 and €95/MWh for other facilities.
- The premium for municipal waste and household waste amounts to €5/MWh.
- The premium for waste from agriculture and agro-food varies between €20 and €30/MWh, depending on flows.
- The premium for sewage treatment waste is €1 to €39/MWh.
- Financial assistance may be granted on a case-by-case basis by the public authorities (ADEME, regional and departmental councils, European Funds, etc.).

3.2. The guarantees of origin system: guaranteeing biomethane traceability

Biomethane injected into a network is "physically" consumed in an area close to its point of injection. However, consumers located anywhere in France (community, private, industrial, etc.) may wish to buy renewable gas through their supply contract. For this, guarantees of origin (GO) make it possible to decorrelate the physical consumption of the biomethane molecule from its contractual sale to a consumer. The GO system ensures that the biomethane injected into natural gas networks can be traced, as well as related operations.

The GO registry is a tool that records quantities injected, exchanged, sold and thus traces each biomethane molecule produced. GRDF has been in charge of managing the register of guarantees of origin since 2012 and this was renewed until 2023 following the most recent tender in 2018.

To access the guarantees of origin website, go to: **https://gobiomethane.grdf.fr/**

The list of suppliers interested in buying biomethane is available on the Ministry of the Ecological and Inclusion Transition website: https://www.ecologique-solidaire.gouv.fr/sites/default/files/20200219-%20%20liste_fournisseurs.pdf

▶ **THE ENERGY AND CLIMATE ACT OF 8 NOVEMBER 2019 REFORMED THE CURRENT SYSTEM OF BIOMETHANE GUARANTEES OF ORIGIN. THE NEW MECHANISM WILL APPLY FROM 9 NOVEMBER 2020.**

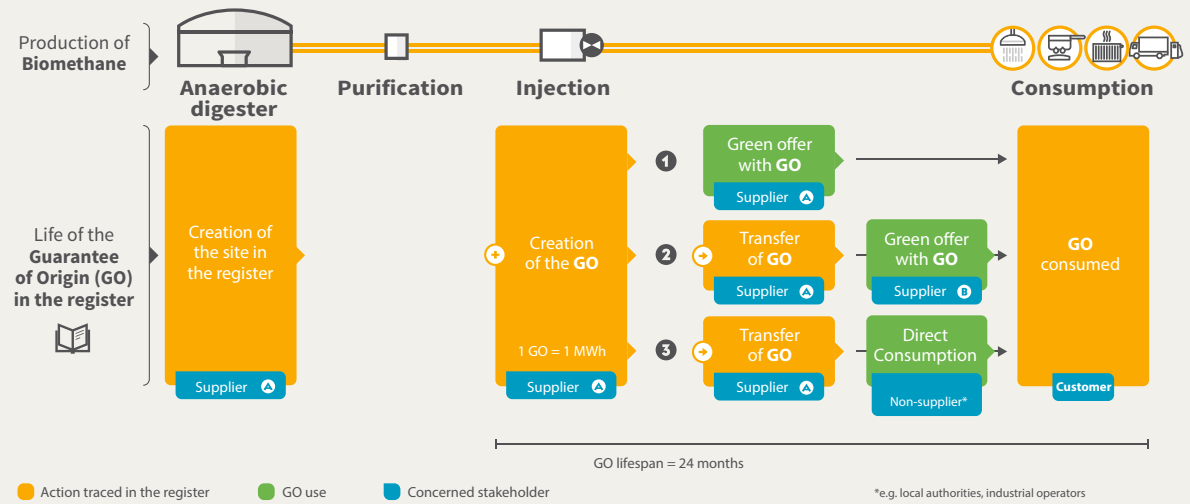
1 GO = 1 MWh of injected biomethane

38 suppliers listed on the GO register on 31/12/2019

95 sites registered out of 123 that inject as of 31/12/2019

41% of GOs used in the form of Bio-NGV over 2019

The guarantee of origin mechanism (GO)
Source: GRDF



3.3. The compensation mechanism associated with feed-in tariffs

A compensation mechanism was set up in November 2011 to refund suppliers for the expenses incurred through purchasing biomethane, namely:

- The additional cost of the biomethane purchase price in relation to the price of natural gas on the wholesale market;
- Related costs: the cost of reporting the guarantees of origin, management costs of the compensation fund, and the management costs of natural gas suppliers implied by purchasing biomethane.

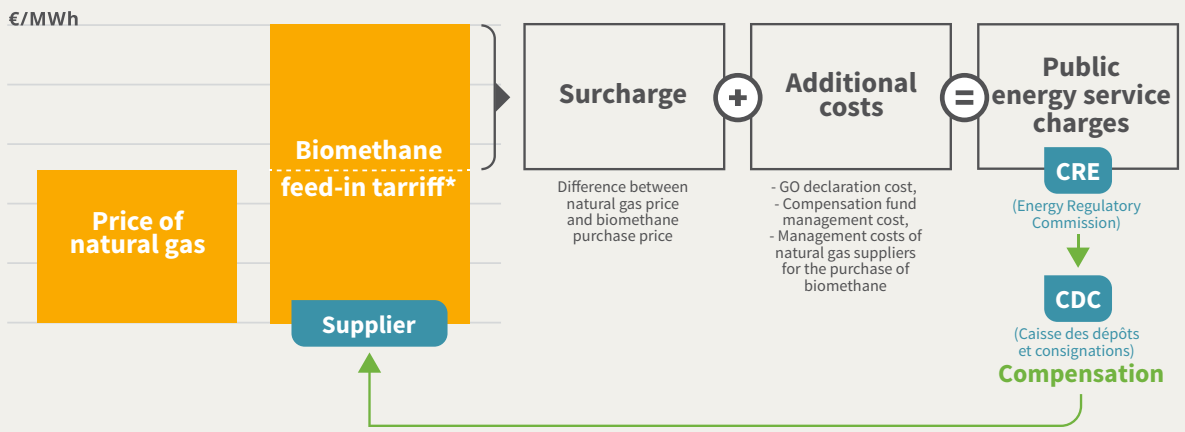
This compensation mechanism is managed by the Caisse des dépôts et consignations (CDC).

The decision of the Energy Regulatory Commission (CRE) of July 2019[16] on the assessment of public energy service charges for 2020 specifies the costs associated with developing biomethane injection in gas networks.

Earmarked account	Expenses recorded 2018	2019 Provision Update	2020 Provisional Load
Biomethane	**€55M**	**€121.1M**	**€248.5M**

A mechanism based on GOs establishes that suppliers should pay back to the Compensation Fund 75% of profits made by valuing the GOs, in order to reduce the public service charges. There is an exception to this rule: in the case of selling biomethane as a fuel for vehicles (Bio-NGV), gas suppliers can retain all the benefits associated with the market value of GOs. It is a strong incentive to increase the importance of biomethane as a fuel.

The compensation mechanism associated with feed-in tariffs
Source: GRDF



* Order of 23 November 2011

16. Decision of the CRE of 11 July 2019 on the assessment of public energy service charges for 2020.

4. The emergence of the right to injection

Infrastructure adaptations are necessary to increase the injection of biomethane into the networks in France. The "right to injection" was conceived to address this issue.

OCTOBER 2018

Promulgation of the EGALIM Law

The Law introduced the following changes:

- Connection of a biomethane producer to the distribution network, even if it is located outside a gas-served zone;
- Connection of a biomethane producer to the transmission network in compliance with the law on distribution pipelines;
- Financing procedures for network adaptation works defined by decree.

JUNE 2019

Publication of the "Right to Injection" decree

The decree sets out:

- A financing framework for network reinforcement, specifying a criterion of relevance and profitability (I/V);
- Procedures enabling third parties (particularly regions) to help develop biomethane;
- Cost-sharing principles for industrial works that make it possible to move away from the principle "first arrived, first paying for others".

NOVEMBER 2019

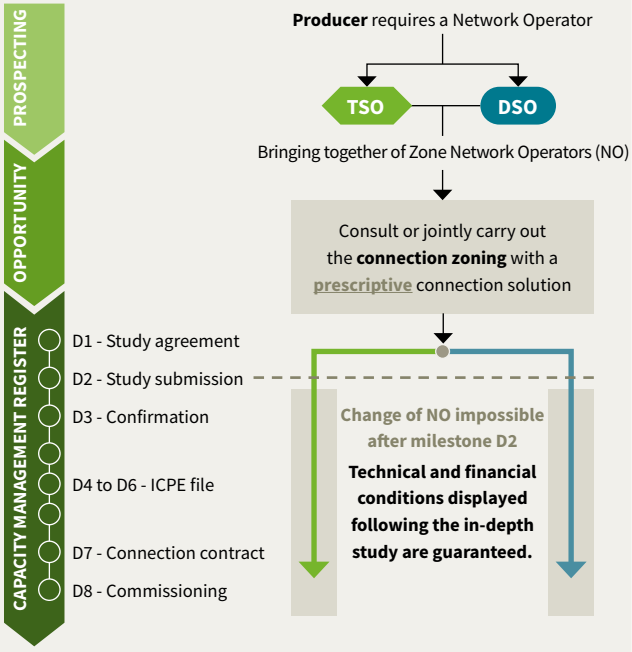
CRE decision on the implementation of the right to injection

The decision defines the procedures for:

- Construction and the rules for establishing prescriptive connection zoning (technical-economic zoning criterion);
- Publication of a map indicating areas eligible for network reinforcement;
- Treatment of shared network connection and equipment (which benefit several producers).

Operator response to producers

Source: Network Operators



In some cases, producers take the two steps in parallel before choosing an option when submitting the study (if the cost/benefit analysis is inconclusive due to the outlet). In other (marginal) cases, producers call upon several TSO and/or several DSO (zones close to the boundaries of GRTgaz/Teréga or GRDF/Local Distribution Company)

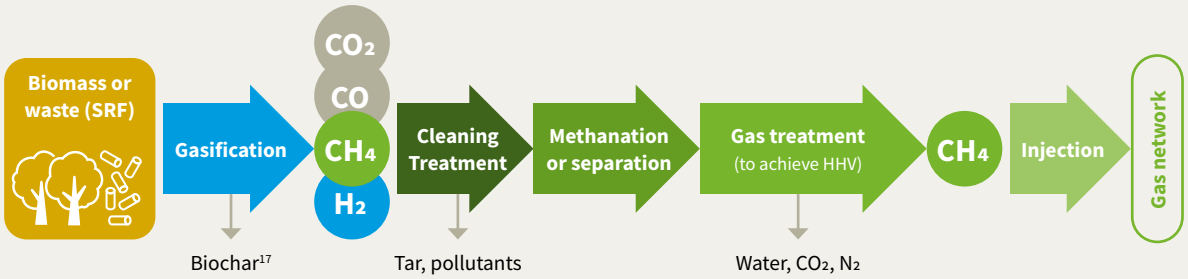
5. New renewable gas production routes

Anaerobic digestion is now the leading mature renewable gas production technology. In the medium and long term, new renewable gas production and recovery processes will develop:

- Pyro-gasification of dry biomass residues or final prepared waste such as SRF (Solid Recovered Fuel);
- Hydrothermal gasification;
- Power-to-Gas, i.e. the production of hydrogen by electrolysis of water from renewable electricity and its recovery, either via direct injection into the grid, or after conversion to synthetic methane by methanation;
- Anaerobic digestion of microalgae.

5.1. Pyro-gasification of biomass and SRF

The pyro-gasification process
Source: GRTgaz



→ THE PYRO-GASIFICATION SECTOR FOR INJECTION INTO THE NETWORKS LOOKS PROMISING

Pyro-gasification, a high-temperature thermochemical process, is used to recover various residual waste (dry agricultural by-products, dried sludge, wood sector residues not recovered elsewhere, fuels produced by sorting at source when these cannot be recovered upstream in the form of material, etc.) to produce a renewable gas (or synthetic gas) that can be injected into existing gas networks. This sector, which processes non-fermentable residual dry waste often destined for landfill or incineration, is a perfect companion to the anaerobic digestion sector.

Pyro-gasification makes it possible to convert into energy many kinds of biomass and waste that are currently either non-recoverable in the form of material, or technically and economically difficult to process in other sectors. Injection into the gas networks resulting from pyro-gasification can:

- contribute, alongside biomethane resulting from anaerobic digestion, to the achievement of renewable gas objectives;
- develop a new sector to deal with typologies of non-food biomass, which is more difficult to recover by means of anaerobic digestion (non-fermentable agricultural residues, ligno-cellulosic biomass, etc.);
- create opportunities for the energy recovery of SRF with an attractive yield and significantly lower atmospheric emissions than combustion, thus contributing to the objective set out by the Energy Transition Act for Green Growth (LTECV) of reducing the quantity of buried waste: - 50% by 2025;
- help develop a circular economy and produce renewable (or recovered) energy in regions at a price that can be controlled, thus improving France's energy independence.

This sector has reached a sufficient stage of maturity that preparations are being made to launch the first industrial units in 2023.

Stakeholders believe that by 2028, injected gas from pyro-gasification processes would allow for the recovery of nearly half a million tonnes of waste per year and the injection of 1 TWh of gas per year, thus reducing CO_2 emissions by around 165,000 tonnes.

The large-scale development of the sector will therefore make it possible to address a significant part of the growing waste problem in the regions, while generating low-carbon, high-efficiency energy (between 70-80%) that is produced locally, storable and transferable, and fully interchangeable with natural gas. To do this, a support system for the initial projects will have to be put in place.

Pyro-gasification is the subject of numerous projects and pilots schemes around the world, particularly in France where there are the following initiatives:

- Gaya – Saint-Fons experimental platform (managed by ENGIE) – see box on page 24.
- Plainenergie – Plaine de l'Ain Industrial Park (coordinated by PROVADEMSE)
- Cometha – Ile-de-France (managed by SIAAP – SYCTOMI)
- Synthane – Compiègne (managed by ETIA)
- Salamander – Le Havre (managed by ENGIE)
- R-Hynoca – Strasbourg (managed by R-GDS)

Synthetic biomethane will benefit from the development actions already carried out (or under way) for biomethane injection: injection skid, meshing, reverse flow units, etc.

17. Biochar is a soil amendment resulting from biomass pyrolysis.

IMPLEMENTATION EXAMPLE: GAYA, THE FIRST DEMONSTRATOR IN FRANCE

Led by ENGIE, the GAYA project brought together 11 partners of excellence with complementary know-how to demonstrate the technical, environmental and economic feasibility of producing biomethane by pyro-gasification of dry biomass. The project, which was completed in December 2019, received financial support from ADEME to the tune of €19 million.

Inaugurated in October 2017, ENGIE's experimental platform located in St-Fons (Auvergne-Rhône-Alpes), in the Vallée de la Chimie, implements an innovative chain of semi-industrial biomethane production processes to reduce production costs and check the technical and environmental performance. With regard to the latter, the project carried out a life cycle analysis to assess the environmental impacts of this new sector and provide working groups and the public authorities with information about these issues.

Gaya project platform

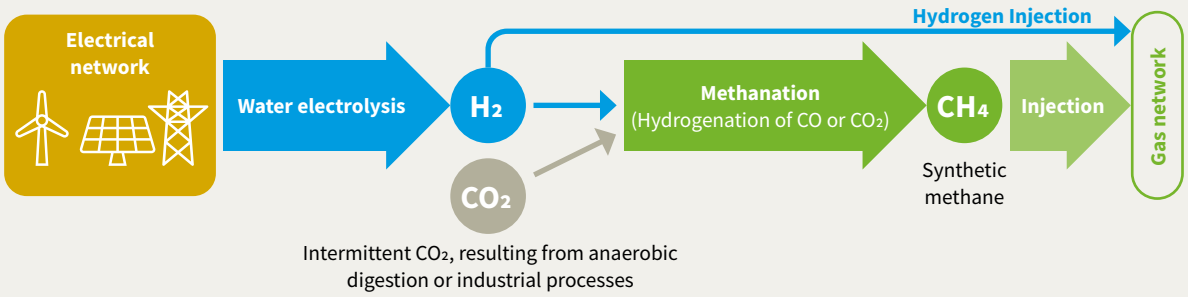
Today, around 15 engineers and technicians are employed on the site in the combined fields of R&D and operations. The entire production chain has been demonstrated for dry biomass, from biomass supply to its continuous conversion into synthetic gas and then biomethane. The tests also checked the functionality of the innovative methanation reactor designed by ENGIE's Corporate research centre, ENGIE Lab CRIGEN, which handles and converts both synthetic gas (from pyro-gasification) and a mixture of CO_2 and H_2 (typical of a Power-to-Gas chain) to produce biomethane.

In the future, the platform will diversify the raw materials used by focusing on unrecoverable solid organic residues (such as solid recovered fuels (SRF), fractions of non-recyclable plastics, waste wood (Grade-B wood), etc.).

Source: Biomethane from gasification - production potential in France by 2020 and 2050, GRDF Study conducted by ENGIE and co-managed by ADEME, MEDDE, MINEFI & MAAF, February 2013

5.2. Power-to-Gas: a new tool for decarbonising the energy system

The Power-to-Gas process
Source: GRTgaz



As described in the Hydrogen Plan for the Energy Transition (June 2018), Power-to-Gas is a useful tool for:

- decarbonising gas uses;
- maximising the integration of renewable electricity into the energy system;
- offering an inter-seasonal energy storage solution.

Hydrogen can be integrated into gas infrastructures by:

- mixed injection of H_2 into the existing pipes;
- methanation, by recombining hydrogen with CO_2 (for example from anaerobic digestion);
- the conversion or creation of 100% hydrogen networks.

In a joint report published in 2019[18], gas infrastructure operators confirm that it is possible to integrate a significant volume of hydrogen into the gas system by 2050, with limited adaptation costs. In the short term, a rate of 6% by volume of blended hydrogen is achievable in most networks, with very few adaptations. This is compatible with most current gas consumers' installations. As a result, gas infrastructures will be able to accommodate decarbonised and renewable hydrogen, whether through the recovery as an industrial co-product, from the pyro-gasification of waste or biomass, from gas reforming with carbon storage, or from Power-to-Gas.

To facilitate the rollout of projects, gas operators recommend setting a target capacity for the integration of blended hydrogen into the networks at 10% by 2030, then 20% beyond this day. This will allow for the adaptation of appliances, in particular that located downstream of the infrastructure, and for their certification at this level of hydrogen.

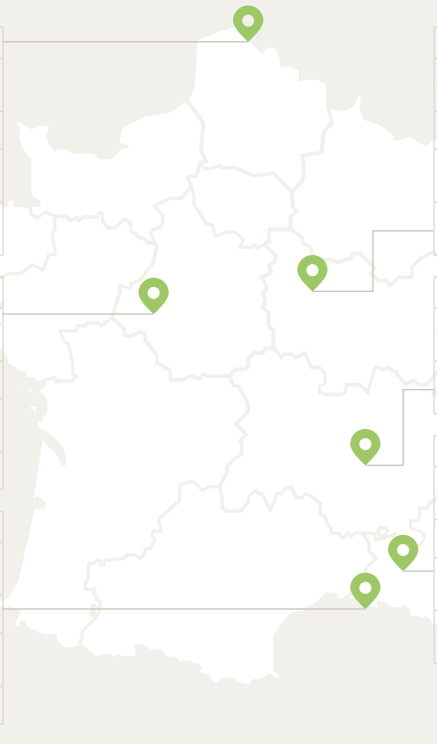
The law now authorises access to the network for low-carbon hydrogen and renewable hydrogen (Article L111-97 of the French Energy Code). Infrastructure operators study the connection requests from producers of hydrogen and more generally of synthetic gas that is more or less hydrogenated (pyro-gasification, hydrothermal gasification, etc.) or made from hydrogen (methanation). The connection and injection methods and procedures have yet to be defined. A hydrogen injection working group was launched by GRTgaz with gas infrastructure operators, public authorities, the gas standardisation office, professional associations from the sector and local authorities to set out the methods and procedures relating to the connection and injection of hydrogen and synthetic gas production.

For several years now, French infrastructure operators have been studying both the technical and economic aspects of these different channels. This is reflected in their commitment to several demonstrators.

18. Report on the technical and economic conditions for injecting hydrogen into natural gas networks – GRTgaz, GRDF, Elengy, Storengy, Teréga, R-GDS, Regaz, SPEGGN, Geomethane – June 2019

Infrastructure operators' main Power-to-Gas projects as of 1 April 2019

Source: Network Operators



GRHYD (operational)
- Engie, Areva H2Gen, CEA, Engie Ineo, GRDF, McPhy, CUD, ADEME, INERIS, CETIAT, etc.
- Electrolyser 10 Nm³/h — €15M
- Power-to-Gas, mixture recovery for 100 housing units
- Injection distribution (up to 20% H_2) — CH_4 / H_2 mixtures

MethyCentre (under study)
- Storengy, Atmostat, Areva H2Gen, CEA, Prodeval, ADEME, etc.
- 250 kWe electrolyser — €12M
- Power-to-Gas, catalytic methanation with CO_2 from biogas
- Gas networks injection — $SynCH_4$ / H_2

Jupiter1000 (under construction)
- GRTgaz, CEA, Atmostat, RTE, Teréga, McPhy, Leroux & Lotz, etc.
- 1 MWe electrolyser — €30M
- Power-to-Gas, catalytic methanation with industrial CO_2 (25 Nm/h)
- Transmission injection — $SynCH_4$ / H_2

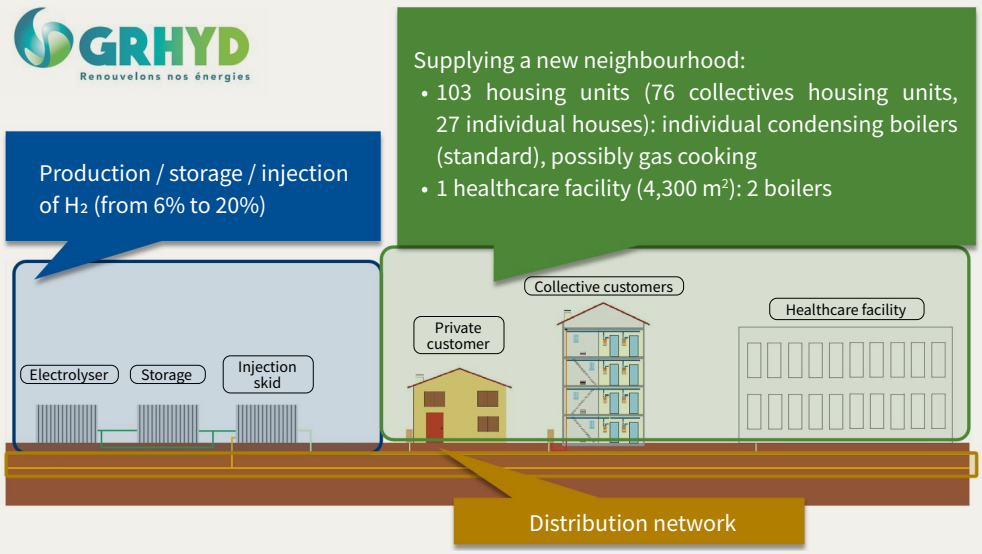
Hycaunais (under study)
- Storengy, Areva H2Gen, Engie, Electrochaea, Waga Energy, etc.
- 1-2 MWe electrolyser — €9M
- Power-to-Gas, anaerobic digestion and biological methanation coupling
- Planned gas network injection — $SynCH_4$

Zero Emission Valley (under construction)
- AuRA, SME, Ataway, Michelin, Engie, etc. — €70M
- 15 electrolysers, 20 charging stations and 1,000 vehicles

HyGreen (under study)
- DLVA agglomeration community, Geomethane, PACA, etc.
- 13 kt H_2/year (0.5 TWh) — €300M
- Power-to-Gas for mobility (bus+train) and injection, salt cavity storage
- Planned transport injection — H_2

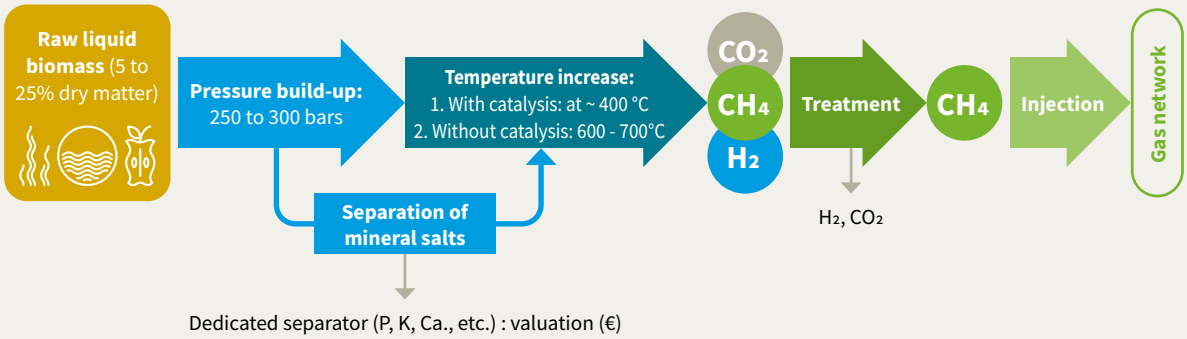
▶ IMPLEMENTATION EXAMPLE: GRHYD

The challenge for GRDF is to play a part in the emergence of solutions that contribute to the complementarity of the networks and the greening of the gas transported, while guaranteeing gas quality, continuity of supply, and safety. It is also necessary to provide for the adaptation of the operating protocols relating to the distribution of the hydrogen/natural gas mixture. The demonstrator was officially inaugurated on 11 June 2018. A first phase of preliminary studies and laboratory tests was completed at the end of 2017. The equipment (electrolyser, storage, injection station) was built and delivered during 2017 and early 2018. The actual demonstration period began with the injection in June 2018, enabling the hundred housing units in the new district, as well as the boiler unit of a tertiary establishment, to be supplied with a mixture of natural gas and hydrogen at variable levels of hydrogen incorporation up to 20% (steps of 6%, 10%, 20%, then a phase with a variable rate between 0-20%). The increase to 20% occurred on 11 June 2019, and the hydrogen level has been variable since December 2019. Tests at the 6%, 10% and 20% stages showed the boilers operating normally. The network feedback is also satisfactory.



5.3. Hydrothermal gasification

The hydrothermal gasification process
Source: GRTgaz



Hydrothermal gasification is a high-pressure, high-temperature (400-700°C) thermochemical process to convert liquid biomasses with a low rate of dry matter (between 5-25%) into a synthetic gas rich in methane that can be injected into the gas networks after purification. Hydrothermal gasification is used to recover:

- Industrial effluents and liquid residues
- Digestates from anaerobic digestion or even directly:
  - → Municipal and industrial sewage sludge (STEP);
  - → Livestock effluents (slurry and manure) and other liquid residues of agricultural origin;
  - → Urban liquid organic waste

Hydrothermal gasification converts almost all carbon into gas, drastically reducing the amount of final waste to be managed. It is also used to recover valuable mineral salts (phosphorus, calcium, potassium) and clear, residual water that is rich in ammonium, while offering an energy efficiency of at least 70%. The main developers estimate that the technology could reach an industrial scale by 2023/2025, with modular systems with a unit size of between 0.5-6 t/h.

According to a recent study, the potential yield of renewable gas from this technology in France, according to the assumptions for the mobilisation of identified deposits, is between at least 58 to 138 TWh/year by 2050. The first operational facilities could be on the ground in France as early as 2025.

A FIRST PRE-INDUSTRIAL DEMONSTRATOR IN EUROPE:

After a test phase with a first 2 MWth unit installed at the end of 2018, the SCW Systems project in Alkmar, Netherlands, aims to expand to 10 identical installations, reaching a total of 20 MWth.

Introduction to stakeholders

As France's leading natural gas distributor, GRDF operates and develops the natural gas distribution network in more than 9,500 municipalities. Owned by the local authorities, this near-200,000 km network promotes biomethane. Through its support of project owners, GRDF is accomplishing its commitment to develop innovative energy transition solutions throughout the regions. GRDF conducts feasibility studies, supplies biomethane injections to the network (counting, quality control and pressure regulation). Finally, the company has been in charge of the registry of guarantees of origin since December 2012 (public service delegation renewed in 2017).

GRTgaz is one of the largest natural gas transmission operators in Europe and is a world expert in gas systems. In France, GRTgaz owns and operates 32,500 km of buried pipelines and 26 compressor stations to transport gas between suppliers and consumers (distributors or industrialists directly connected to the transmission network). GRTgaz employs 3,000 people and carries out public service duties in order to guarantee that supply to consumers continues, and offers users or future users access to its gas transmission network. GRTgaz, as a player in the energy transition market, invests in innovative solutions to adapt its network and reconcile competitiveness, security of supply and environmental preservation.

As a professional union of municipal and similar gas companies, it brings together 29 local gas companies that actively promote natural gas and biomethane. In addition to their desire to perpetuate safety, quality and continuity requirements that have always been essential components of the public gas distribution service, members of the SPEGNN, in accordance with the missions entrusted to them by communities, are local players, fully involved in the energy transition.

There are 400 members in the French Syndicate for Renewable Energies (SER) and it represents more than 150,000 jobs. This professional union connects industrial players involved in renewable energy sectors: wood energy, biofuels, wind power, renewable 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 energies industrial sector in France and promote the domestic creation of jobs and added value.

Located in the Grand Sud-Ouest region, an intersection for the major European gas flows, Teréga has been deploying its exceptional expertise in transmission and gas-storage infrastructure development for over 75 years. It is now designing innovative solutions to meet the major French and European energy challenges. A genuine accelerator of the energy transition, Teréga has over 5,000 km of piping and two underground storage sites which represent 15.6% of the French gas transport network and 24.5% of national storage capacity, respectively. In 2018, the company generated a turnover of €476 million and has over 600 employees.

The following have contributed to this edition:
GRDF: Alexis MASSE, Julie PINEL, Ony RABETSIMAMANGA
GRTgaz: Mathieu BARNETO, Mathilde GARRET
SER: Robin APOLIT, Johanna FLAJOLLET-MILLAN, Françoise JOUET, Quitterie VINCENT
SPEGNN: Roger BOCK
Terega: Grégory BUGLER, Didier MARRON

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GRTgaz Société Anonyme with a capital of €538,165,490 / RCS Nanterre 440 117 620 / www.grtgaz.com
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SPEGNN - Syndicat Professionnel des Entreprises Gazières municipales et assimilées www.spegnn.org
Teréga Société Anonyme with a capital of €17,579,088 / RCS Pau 095 580 841 / www.terega.fr