RENEWABLE GAS
FRENCH PANORAMA
2017

Foreword

The objective for renewable gas to account for 10% of gas consumption by 2030, defined in the French Energy Code, was set with a view to limiting global warming to 2°C by 2050. According to gas network operators and the Syndicat des Énergies Renouvelables (SER), to limit global warming to 1.5°C – a new objective set under the Paris Agreement – the rate of renewable gas development must be accelerated. This will then make it possible to improve the balance of trade. The purpose of renewable gas production is to reduce fossil gas imports, while increasing local energy production.

In 2017, work has begun to revise the Multiannual Energy Programme (PPE[1]), whose current production target for biomethane injection is 8 TWh in 2023. Network operators and the SER proposed an acceleration of renewable gas development with a realistic target of 60 TWh by 2028, including over 50 TWh biomethane derived from anaerobic digestion and 5-10 TWh renewable gases from other processes (pyro-gasification, Power-to-Gas). This acceleration will make it possible to avoid the emission of nearly 14 million tons[2] of greenhouse gases by 2028.

Stakeholders in the anaerobic digestion sector, the first renewable gas production chain to date, are working together to improve biomethane production and the progressive decarbonation of the natural gas network. In order to report on sector growth, GRDF, GRTgaz, SPEGNN, SER and Teréga are continuing to collaborate and publish, for the third time, detailed inventories of biomethane injection on regional, national and European levels.

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

The third edition of the "Renewable Gas French Panorama" is an update of data from network operators registered in France[3] by 31 December 2017. 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.

→ RENEWABLE GAS INJECTION CONFIRMS ITS UPSWING IN 2017

In 2017, the sector was keeping up its momentum. The quantities of injected biomethane practically doubled compared with 2016: 406 GWh[4] were injected into the gas network, compared with 215 GWh in 2016, representing **an annual increase of 89%**. The facilities had a maximum annual injection capacity of 682 GWh at the end of 2017, compared to 410 GWh at the end of 2016. The difference between the quantities injected and the installed capacity comes almost exclusively from the fact that many installations were successfully commissioned at the end of 2017.

However, the true measurement of the 2017 trend can be seen in the new capacity reservations; with 120 new projects listed on the capacity management register, representing 2.8 TWh, compared with 56 in 2016 (corresponding to 1.6 TWh). Cumulatively, at the end of December 2017, the equivalent of 8 TWh of biomethane capacity in projects was reserved in the injection capacity management registry, which is the equivalent of the PPE injected-biomethane objective for 2023.

The current tendency is the result of the investment and collaboration of all sector stakeholders, in particular within the biomethane injection working group piloted by ADEME and GRDF. Renewable gas professionals are continuing their efforts to generate and complete an increasing number of projects.

1. PPE : in French, Programmation Pluriannuelle de l'Énergie.
2. Calculations based on a hypothesis of 60 TWh renewable gases and on the results of the ENEA - Quantis study "GHG impact assessment of biomethane injection in natural gas networks"
3. To date, no biomethane injection projects exist in overseas territories and communities or in Corsica (network operators).
4. 1 TWh = 1,000 GWh = 1,000,000 MWh = 1,000,000,000 kWh

The year 2017 was marked by **the implementation of two measures** in favor of the sector's development:

- **the tariff rebate** on the costs of biomethane connection to the distribution network,
- **the opening of underground storage** to biomethane derived from anaerobic digestion.

It is important to consolidate 2017 developments and to endorse pending regulatory developments to ensure that PPE injection targets are met. To keep up with the current trend, which continues to grow in the first quarter of 2018, it is essential to rapidly implement the measures announced in March 2018 within the framework of the Anaerobic Digestion WG launched by the Secretary of State, Sébastien Lecornu, particularly the adaptation of gas infrastructures.

To facilitate a significant boom in biomethane, an industrial roadmap should be established to achieve the cost reduction prospects demonstrated by an ENEA study[5]. According to this study, a reduction in costs of around 30% is conceivable by 2030.

→ A GAS NETWORK IN LINE WITH THE ENERGY TRANSITION

To meet the objectives set by the State, distribution and transport network operators are developing solutions to maximise volumes injected while guaranteeing the safety and security of the French gas network. The networks will therefore be ready to accommodate new generations of renewable gases produced by pyro-gasification and Power-to-Gas technologies.

In 2017, French storage system operators lifted the last barrier to the free circulation of biomethane on the entire gas network. Indeed, Storengy and Teréga decided to allow the injection of biomethane produced by anaerobic digestion in their underground storage, following the joint completion of technical studies. This decision significantly increases the potential for biomethane injection into networks. It will particularly promote the implementation of reverse flow installations, which enable locally produced gas to feed into higher pressure levels in the network, thus lifting a part of the summer consumption constraint in injection zones.

→ RENEWABLE GASES ARE IN THE HEART OF REGIONS

The biomethane produced by anaerobic digestion as part of the circular economy has numerous advantages for the French regions and agricultural sector. It creates direct jobs with maintenance of agricultural operations, local recycling of waste, return of digestate soil as natural fertiliser. As a result we can see a decorbonation of energy and agricultural systems, and the dynamism of rural regions.

The skill enhancement of all actors in the value chain, and the structuring and progressive professionalisation of the sector made it possible to reach 2,250 direct full-time equivalents (FTE)[6] (for 5,000 estimated indirect FTE) and a turnover of 600 million euros in 2015. The biomethane sector can create on average 3-4 local jobs per installation that cannot be relocated, solely within operations.

5. Overview of the biomethane sector in France and ideas for its development, ENEA Consulting, 2017
6. The data is limited to direct jobs associated with biogas energy recovery: the anaerobic digestion of household waste and sludge, agricultural and regional anaerobic digestion, and biogas from storage facilities for non-hazardous waste (SFNHW). Those linked to the collection of biowaste (upstream of the energy production chain) and to the management of digestate are considered indirect jobs and, consequently, are not included, as for other indirect jobs (suppliers of manufacturers). (ADEME)

THE MESSAGE FROM OPERATORS OF DISTRIBUTION AND TRANSPORT NETWORKS

"Gas infrastructure has been sized to meet a demand, particularly for heating. The 11 million clients connected to the transport and distribution networks benefit from gas storage capacities to satisfy their needs all year round, especially during the toughest winters. Gas infrastructure is essential to the safety of supply, in particular to managing the winter electrical demand peak.

Changes brought by the energy transition are resulting in a move towards a decarbonised system. Renewable gases are thus effectively contributing to the energy transition by decarbonising uses, as in the building and transport sectors.

They also have the advantage of corresponding to continuous, easily-storable energy production. The renewable gas sectors are all the more interesting in that they propose solutions at the regional level, both for the management of waste and agricultural residues in the case of biomethane, and for the flexibility of the power grid and management of renewable electricity in the case of Power-to-Gas.

Gas infrastructure should nevertheless be adapted to ensure the injection of all of these renewable gases at a controlled cost for the community. The professions and missions of network operators will therefore end up evolving in order to offer reverse flow installation solutions, and to collect and capture biomethane production potentials by connecting production sites."

Contents

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 composed of 50-65% methane. Organic matter can come from various sectors: agricultural, industrial, catering waste, community waste, gas from storage facilities for non-hazardous waste (SFNHW)[7], 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 the 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. In this respect, ADEME considers biomethane fuel recovery to be an excellent form of biogas recovery because it has significant potential to reduce GHG emissions. 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.

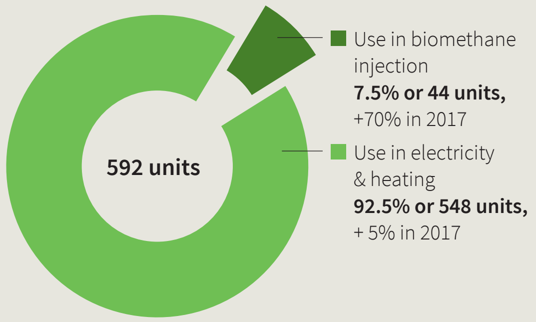
Given all these advantages, biogas production has been part of the renewable energy development strategy in France since 2011. The Energy Transition Act for Green Growth (LTECV[8]) reinforces the ambitions attributed to the biomethane injection sector.

7. Gas produced in landfills, mainly resulting from the anaerobic degradation of biodegradable organic matter.
8. In French, Loi de Transition Énergétique pour la Croissante Verte.

At the end of 2017, France had 592 biogas production units[9], 44 of which recover it in the form of biomethane injected into natural gas networks. Even more recently (injection has been authorised since the end of 2011), the sector has seen significant development with a veritable boom in 2017 (volumes injected demonstrating growth of +89% between 2016 and 2017). This boom reaffirmed itself in the first quarter of 2018 and is especially apparent in the increase in new capacity reservations.

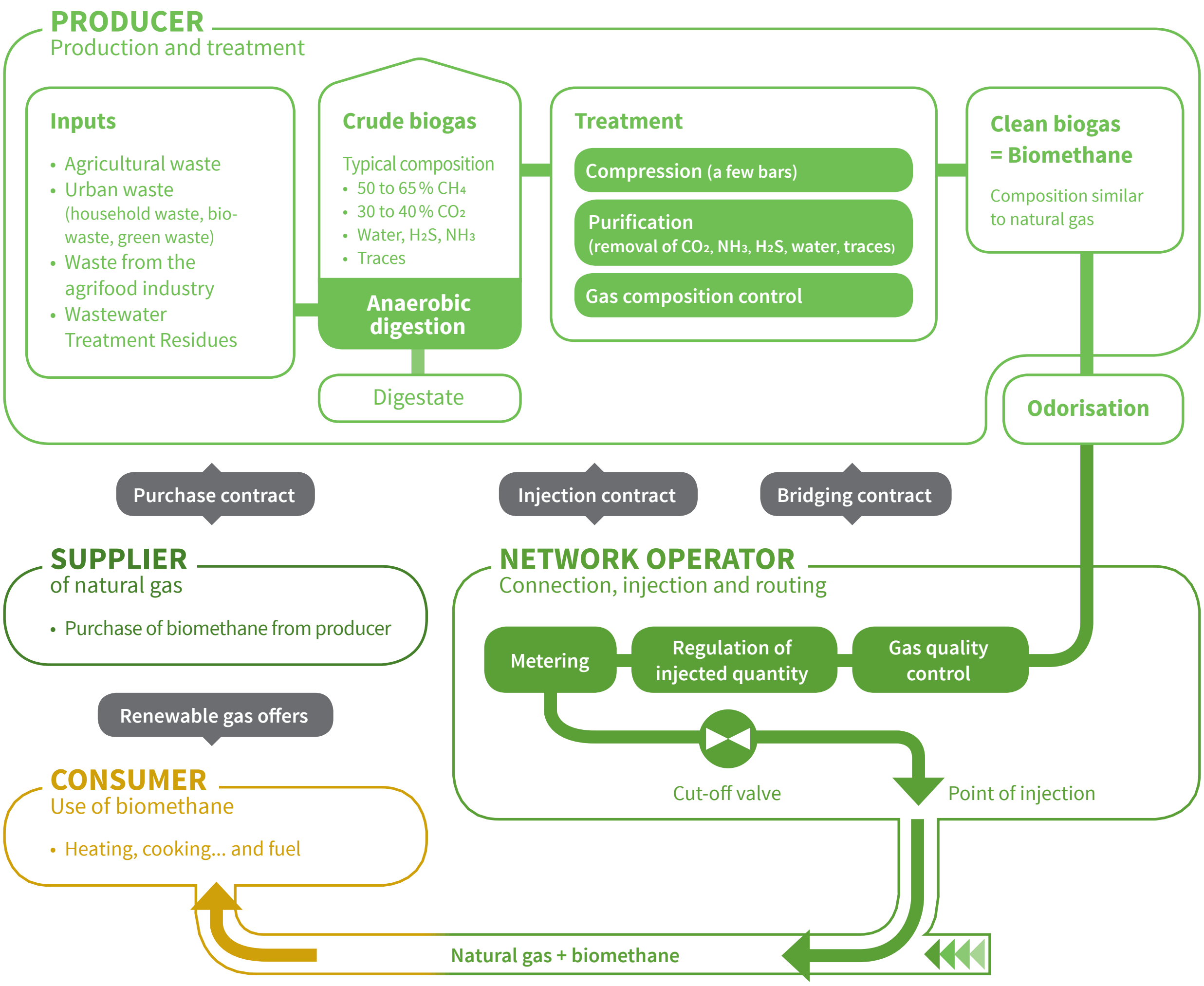
Biogas units by valuation in France (2017)

Source: network managers, December 2017



From anaerobic digestion to injection: distribution of roles

Source: GRDF

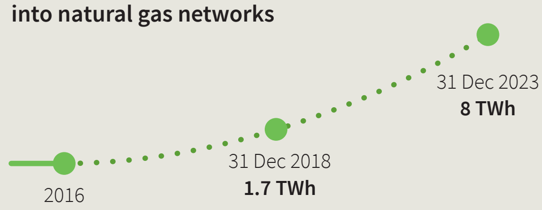


9. MTES dashboard at the end of 2017

→ OBJECTIVES FOR THE BIOMETHANE SECTOR

The Decree governing the Multiannual Energy Programme (PPE) under the Energy Transition Act (Article 176) was published on 27 October 2016. The objectives are based on two roadmaps: the first last three years (2016-2018) and the second, five years (2019-2023). This is the first regulatory text providing the biomethane sector with developmental objectives. The developmental objectives for biomethane injection into the gas network in terms of overall production are 1.7TWh in 2018 and 8 TWh in 2023. The development of this sector is accelerating. With 8 TWh of injection capacity already reserved at the end of 2017, the objective set by the previous PPE is achievable.

PPE targets for the injection of biomethane into natural gas networks



As part of the work on the new PPE, the sector has an objective of 50 TWh in 2028.

The objective of 50 TWh of biomethane in 2028 is a realistic figure thanks to the support of public authorities and the commitment of all actors in the sector.

→ BIOMETHANE TO REDUCE CO_2 EMISSIONS

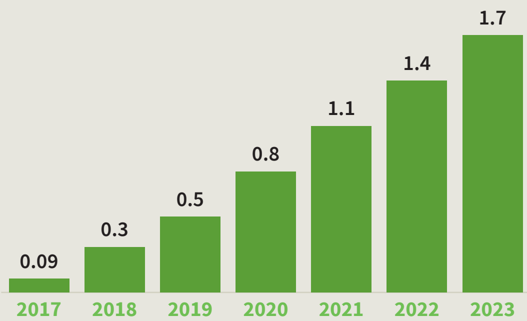
A biomethane life-cycle analysis (LCA) carried out in 2017[10] showed a saving of 218 kg of equivalent CO_2 for each megawatt hour (MWh) of biomethane produced, injected and consumed for heating purposes. The biomethane sector therefore makes it possible to avoid the emission of 1.7 million tonnes of CO_2 solely in the year 2023 (considering the 8 TWh 2023 PPE objective). Cumulatively, the emission of over 6 million tonnes of equivalent CO_2 could be avoided given the development of the biomethane sector at this time.

When biomethane is used as a fuel (Bio-NGV), almost 80% of greenhouse gas emissions are avoided compared with diesel. Moreover, Bio-NGV also helps to limit local pollutants and improve air quality.

- **BIOMETHANE INJECTION HELPED TO SAVE 90,000 TONNES OF CO_2 IN 2017**
- **BIOMETHANE INJECTION IS EXPECTED TO SAVE 1,740,000 TONNES/YEAR OF CO_2 IN 2023**

Forecasts of the equivalent CO_2 emissions avoided per year by 2023 (Mtonnes CO_2 equiv.)

Source: Estimation according to the LCA ENEA-QUANTIS study



10. "GHG impact assessment of biomethane injection in natural gas networks", Enea-Quantis, 2017

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

→ TYPOLOGY OF BIOMETHANE INJECTION SITES

Bassée Biogaz site
Commune of Noyen-sur-Seine (Seine-et-Marne)
Commissioned 15/11/2017

AUTONOMOUS AGRICULTURE

- carried out by 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

Valois Energie site
Commune of Senlis (Oise)
Commissioned 29/08/2017

TERRITORIAL AGRICULTURE

- 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.)

Bioloie site
Commune of Essarts en Bocage (Vendée)
Commissioned 08/12/2017

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

Ecocéa site
Commune of Chagny (Saône-et-Loire)
Commissioned 17/09/2015

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

SYSTEPUR site
Commune of Reventin-Vaugris (Isère)
Commissioned 31/10/2017

SEWAGE SLUDGE

- urban and industrial

ISDND St-Maximin site
Commune of Saint-Maximin (Oise)
Commissioned 26/06/2017

STORAGE FACILITIES FOR NON-HAZARDOUS WASTE (SFNHW)

→ VARIOUS CLASSES OF INPUTS USED TO PRODUCE BIOMETHANE

One of the advantages of anaerobic digestion is allowing the digestate soil to return, instead of sending it to landfill or incineration.

▶ 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).

▶ INTERMEDIATE ENERGY CROPS / CATCH CROPS

An Intermediate Energy 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

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.

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.

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

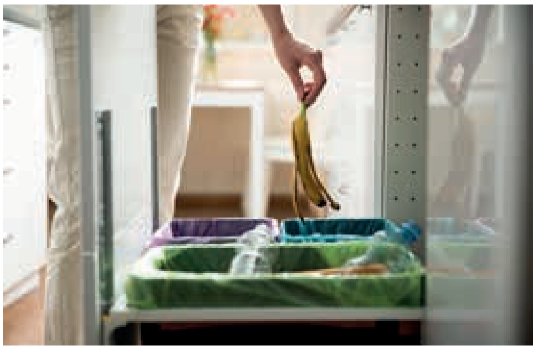
This refers to waste from households and similar waste. Waste generated by municipal services, sewage waste, street-cleaning waste, from markets do not fall within this scope.

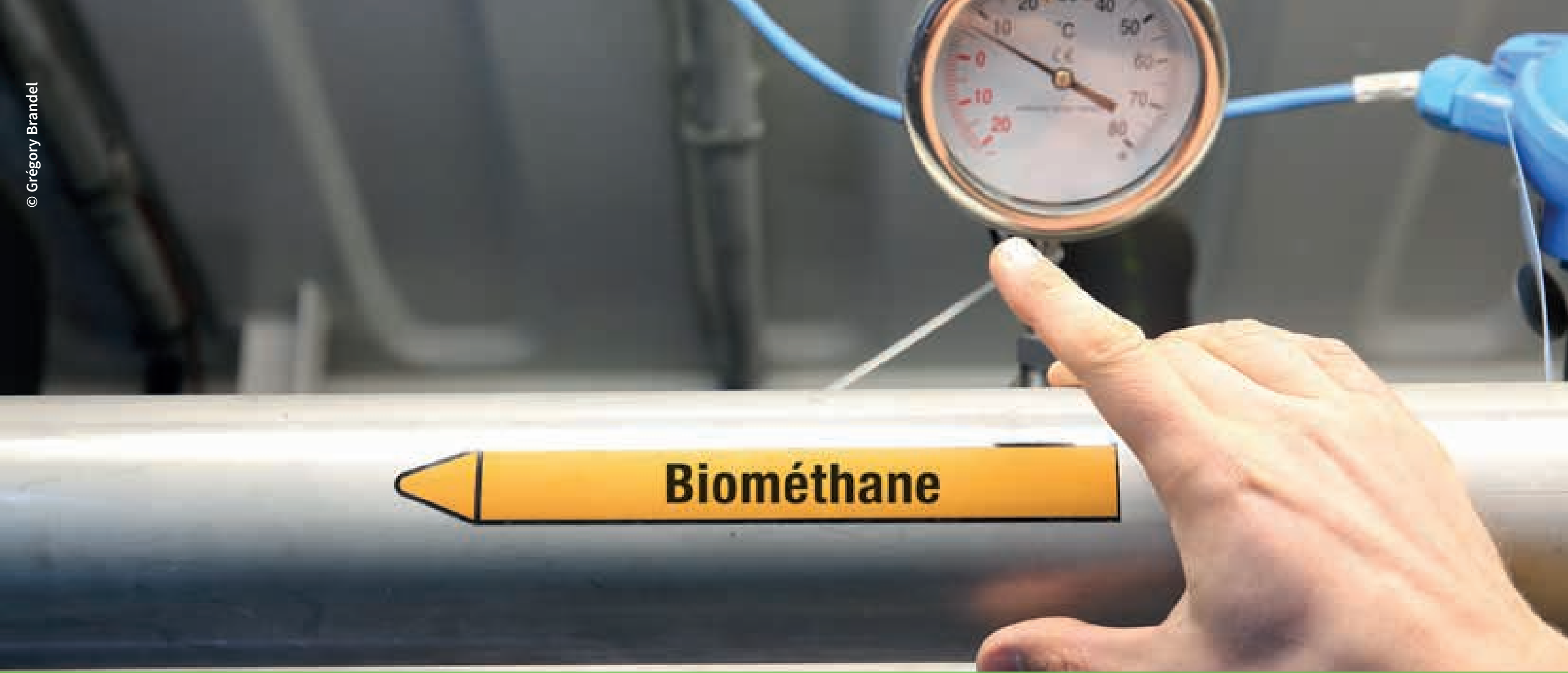
GREEN WASTE

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.



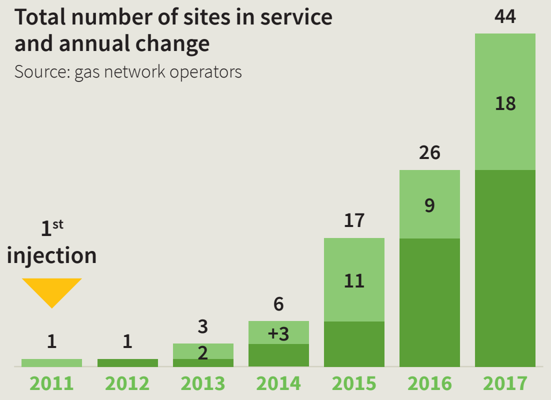


2. Biomethane injection – key figures, development and challenges

2.1. Key figures 2017

Biomethane-connected facilities:
682 GWh/year,
an increase of
66% compared to 2016.

Total number of sites in service and annual change
Source: gas network operators



44
biomethane injection sites
+ 70 % in 2017

406 GWh
renewable production[11]
+89% in 2017

0.1% of
natural gas consumption
88 % in 2017

PRODUCTION FACILITIES FOR THE BIOMETHANE INJECTION SECTOR AS OF 31 DECEMBER 2017

- Biomethane injection sites injected 406 GWh into natural gas networks (+89% in one year).
- The share of biomethane in the national natural gas consumption increased by 88% compared with 2016, which is the equivalent of around 34,000 homes or 1600 lorries/buses.
- Production equipment increased by 70% in one year.

AA. Energy injected into the natural gas network in 2017

QUEUED PROJECTS AS OF 31 DECEMBER 2017 (see paragraph 4.1)

- A project is included in the connection queue when it reaches the Phase II study order: feasibility studies for transport networks (GRT) and detailed studies for distribution networks (GRD). At this stage, a project will take 2 to 5 years to complete.
- The maximum cumulative capacity[12] of the 361 projects registered in the biomethane injection plant connection queue is 8 TWh/year – 3 TWh more than at the end of 2016. This corresponds to the average annual consumption of 35,000 buses or lorries running on Bio-NGV, or 663,000 clients, or even 1.2 million new gas-heated dwellings.

8 TWh/year
queued
60 % in 2017

361
queued projects

2.2. Framework development

Significant targets have been set by France and Europe 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.

2.2.1. Regulatory framework

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.

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.

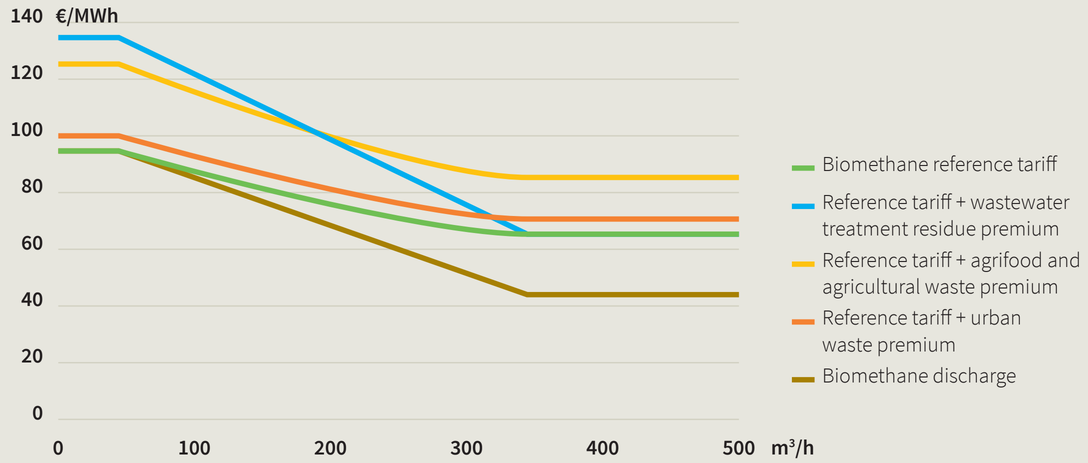
→ INTRODUCTION OF A FEED-IN TARIFF FOR BIOMETHANE INJECTED INTO NATURAL GAS NETWORKS

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, compared with an average of €99/MWh in 2016. 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 can 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.

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.

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 agri-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, the European Fund, etc.).

→ GUARANTEES OF ORIGIN: GUARANTEEING BIOMETHANE TRACEABILITY

▶ THE GUARANTEES OF ORIGIN SYSTEM

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 capacity register since 2012 and this was renewed until 2023 following the most recent tender.

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

▶ TRANSACTIONS

Biomethane producers enter into a purchase contract with a gas supplier of their choice. Guarantees of origin (GO) are attributed to the supplier: each MWh of injected biomethane gives the right to the creation of one GO. Each created Guarantee of origin will be entered in the register by the gas supplier who is purchasing the biomethane. Once established, GOs are valid for 24 months. GO transactions between suppliers are carried out through a transfer between account holders. However, the market is not open to traders. Once a gas consumer uses renewable gas supply, the GO is cancelled.

To sell their biomethane, producers may contact any gas supplier, as defined by the Energy Code, and in particular Article L.443-1.

1 GO = 1 MWh injected biomethane

21 suppliers listed on the GO register

42 sites registered out of 44 that inject as of 31/12/2017

75% of GOs used in the form of Bio-NGV since the creation of the register

Among the suppliers whose gas supply activity in France is subject to ministerial authorisation, some have declared to the Ministry for an Ecological and Solidary Transition that they are interested in buying biomethane. The list of these suppliers, available on the website of the Ministry of Energy, is detailed below.
https://gobiomethane.grdf.fr/documents/fournisseurs/2017-04-27liste_fournisseurs.pdf

List of suppliers interested in buying biomethane

→ THE COMPENSATION MECHANISM ASSOCIATED WITH FEED-IN TARIFFS

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

1. The additional cost of the biomethane purchase price in relation to the price of natural gas on the wholesale market.
2. Related costs: the cost of reporting the guarantees of origin, management costs of the compensation fund, and the costs of managing natural gas suppliers for purchasing biomethane.

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

Act No. 2015-1786 of 29 December 2015 on 2015 Finances (LFR 2015) introduced an energy taxation reform, notably on how public service charges for electricity and gas were to be financed.

These are grouped under the public energy service duties and are integrated into the State budget, where they are distinguished between an earmarked account "Energy Transition" and a budgetary programme "Public Energy Services" as follows:

- the "Energy Transition" account, created under Section 5 of the Finance Act of 2015, includes expenses related to support for renewable energies, electricity or gas;
- the "Public Energy Services" budget programme includes public energy service charges that are not included in the earmarked account, such as management fees.

Since 1 January 2017, following the adoption of the 2017 Finance Act (No. 2016-1917 of 29 December 2016), the earmarked account will be almost exclusively financed by a (37%) share of the Domestic Consumption Tax on Energy Products (TICPE), which notably applies to petroleum products (€6.9 billion from over €17 billion collected nationally by this tax will go to the earmarked account). In accordance with EU regulations, since 1 January 2017, applicable taxes on electricity and gas consumption are paid entirely into the general State budget and no longer go to the earmarked account.

The decision of the Energy Regulatory Commission (CRE) of July 2017[13] on the assessment of public energy service charges for 2018 specifies the costs associated with developing biomethane injection in gas networks.

Earmarked account	Expenses recorded 2016	2017 Provision Update	2018 provisional load
Biomethane	**€18.6M**	**€37.3M**	**€99.5M**

The €29M increase between 2016 and 2017 is part of the envisaged path to commission the new facilities.

A virtuous mechanism backed by the GOs provides compensation into the Fund of 75 % of profits made by the suppliers to the valuation of GOs, in order to reduce the public service charges. There is an exception to this rule: in the case of improving biogas fuel (Bio-NGV), gas suppliers can retain all the benefits associated with the improvement of GOs. It is a strong incentive to increase the importance of biomethane as a fuel.

2.2.2. Additional measures

The first texts of regulations that govern biomethane injection activities are from November 2011 and they aim to promote the development of the sector.

2011	2013	2014	2016
1st regulatory texts for biomethane injection	Text on double valuation: cogeneration and biomethane injection	Authorisation of biomethane injection produced from wastewater treatment residues	In 2016, regulations gave priority to biogas recovery in the form of biomethane injection into natural gas networks over cogeneration, for facilities located in a municipality served by a public gas network and installed electric power network of between 300 kW and 500 kW.

13. *http://www.cre.fr/documents/deliberations/decision/cspe-2018 [in French]*

To go further, the following measurements are recommended in 2018:

- **the maintenance of the current biomethane injection feed-in tariff** over a period sufficient to stabilise this sector until it is totally mature, and its notification to the European Commission;
- **the modification of the typical biomethane purchase contract** to incorporate the notion of "anticipated annual production", in order to smooth out natural variations in the availability of inputs over the year;
- **the implementation of an appropriate support mechanism** for existing sites wishing to switch injection or wishing to carry out mixed usage, and for large-capacity units;
- **the implementation of a support mechanism for non-injected biomethane;**
- **the consolidation of the system of biomethane guarantees of origin and especially the allocation of guarantees of origin to the biomethane purchaser:** this is a condition of the incorporation of anaerobic digestion projects in a circular-economy approach;
- with regard to Bio-NGV, as of 1 January 2017, pursuant to Article 26 of Law 2016-1917 of 29 December 2016 on the 2017 budget, consumption of biomethane for non-fuel uses is exempt from TICGN. **The sector wishes for the use of biomethane fuel (bio-NGV) to be exempted from paying the TICPE [Domestic Consumption Tax on Energy Products];**
- **adaptation of the Energy Code to connect biomethane producers** by:
  - authorising network managers to connect biomethane facilities in non-serviced zones;
  - defining conditions of funding of network developments to connect definite and potential projects;
  - entrusting network managers with the drawing up of development plans to anticipate investment enabling potential biomethane injection.

2.3. How to employ renewable gases?

Developing biomethane production in France is all the more relevant as consumers have a demand and appetite to use renewable gas.

The most iconic use of biomethane comes from mobility. France has become the most dynamic market in Europe in this segment and, 15 years after the arrival of NGV and Bio-NGV buses, today over 11% of the fleet runs on gas. RATP runs bus line 24 in Paris using this biofuel, which is perfectly adapted to noise and CO_2 emission reduction – it also emits practically no fine particulate matters.

Thanks to this renewable gas, an industrialist like Terreal in Chagny, Saône-et-Loire (Burgundy-Franche-Comté) is reducing its CO_2 emissions for its tile production. Biomethane enables gas consumers to access renewable energy without changing facilities, while retaining facilities offered by natural gas. The towns of Outreau in Pas-de-Calais (Hauts-de-France) and of Bourg-en-Bresse in Ain (Auvergne-Rhône-Alpes), for example, have chosen renewable gas in their energy mix.

The Parisian urban heating company (CPCU) is also expected to start using biomethane to supply its heating network.

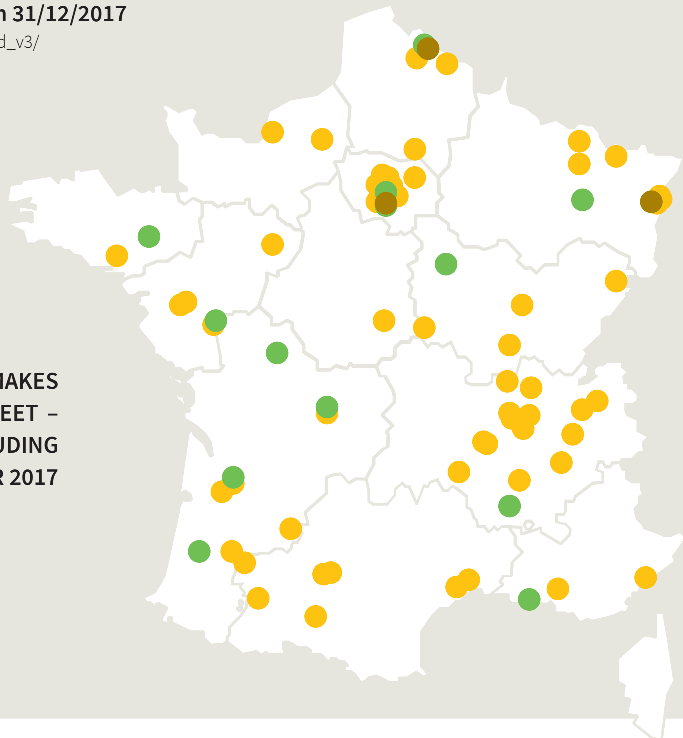
Today buses run on Bio-NGV
Source: Pascal Aimar / CAPA Pictures - GRDF

→ FOCUS ON MOBILITY

Today, 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 regional initiatives: the Nouvelle-Aquitaine region is supporting 10 stations by subsidising the price of Bio-NGV compared with the price of NGV, for a period of 2-3 years[14].

Inventories of public NGV stations in France on 31/12/2017

Source: https://gnv-grtgaz.opendatasoft.com/pages/dashboard_v3/

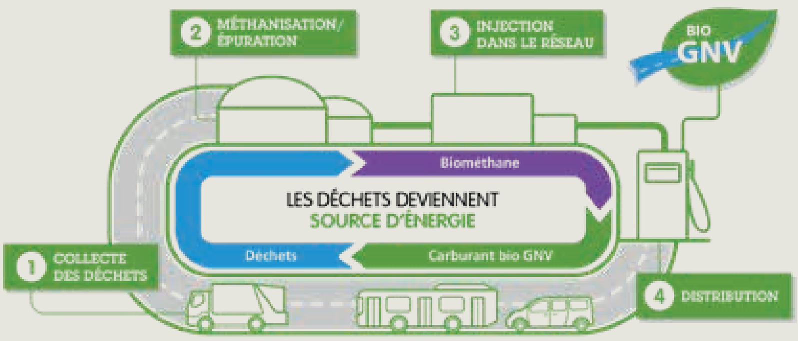


NGV fuel / Bio-NGV:
- CNG
- LNG
- LNG, CNG

▶ **THE OFFER OF NGV STATIONS TODAY MAKES IT POSSIBLE TO SUPPLY THE FRENCH FLEET – COMPOSED OF 16,125 VEHICLES, INCLUDING 1,285 HGV AND 3,064 BUSES IN NOVEMBER 2017 – WITH BIO-NGV FUEL.**

NGV (Natural Gas Vehicle) and Bio-NGV

NGV is natural gas used as fuel; it is the same gas as that used for heating or cooking. Bio-NGV, sourced from biomethane, is also used as a fuel.



8.7% Bio-NGV in NGV in relation to a PPE objective of 20% in 2023

Bio-NGV -80% CO_2 compared to diesel

Faced with major urban pollution issues, highlighted by numerous episodes of pollution peaks in large cities, and considering the decision of the French Council of State on 12 July 2017, the improvement of air quality is at the centre of public authorities' concerns.

While the transport sector has already largely reduced its local pollution emissions in recent years, it remains a strong contributor.

NGV and Bio-NGV account for up to 50% of the reduction in nitrogen oxide (NOx) emissions and 95% of those no fine particulate matter, in relation to the new Euro VI standard.

14. Call for Expressions of Interest in the Nouvelle-Aquitaine region
“Moving towards a renewable fuel station network for freight and passenger transport in Nouvelle-Aquitaine”

2.4. Mapping biomethane injection in Europe

Overview of biomethane injection in Europe

Source: GRDF and CRIGEN / ENGIE “Biomethane injection in Europe - Summary of work 2015 - February 2016” & Biomethane Observatory September 2017 SIA PARTNERS - FRANCE BIOMETHANE

INJECTION IN EUROPE IS CONTINUING ITS GROWTH WITH 30 NEW FACILITIES IN 2017, BRINGING THE TOTAL NUMBER OF FACILITIES IN SERVICE TO AROUND 450, WITH AN ANNUAL PRODUCTION OF AROUND 18 TWh

United Kingdom
Biomethane production has been subsidised since 2011. In 2017, **81 sites** represent a maximum installed capacity of 3 TWh/year.

Netherlands
Biomethane has been being injected into the distribution network for over 20 years, including biogas from landfills. In 2017, **28 sites** injected **more than 900 GWh/year.**

Finland
In 2016, **11 sites** were injecting more than **100 GWh/year** into the natural gas distribution network.

Sweden
In 2016, **18 sites** were injecting more than **470 GWh/year** into the natural gas distribution network.

Norway
In 2017, **3 sites** injected **120 GWh/year**.

Denmark
In 2017, **19 sites** injected **1,750 GWh/year.**

Luxembourg
In 2016, **3 sites** were injecting into the natural gas network for a maximum installed capacity of **62 GWh/year**.

Austria
Austria has injected biomethane into the grids since 2005, and today **13 sites** inject more than **250 GWh/year**.

Germany
In 2016, **204 units** were injecting **10,200 GWh/year** of biomethane into the natural gas network for a maximum installed capacity of 22 TWh/year.

Switzerland
The country has been injecting biomethane in networks since 1997. In 2016, **35 sites** injected **539 GWh/year** biomethane.

Italy
At the end of 2017, **2 sites** were injecting into the networks.

Spain
In 2015, the Valdemingomez site, with a maximum capacity of **23 GWh/year**, injected into the transport network. There is currently no incentive policy for biomethane in Spain.

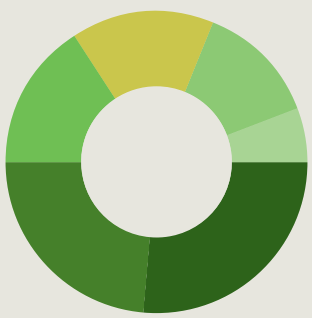
France
In 2017, **44 sites** (+18 sites compared with 2016) with a maximum installed capacity of 682 GWh/year injected **406 GWh/year** into the natural gas network.

3. Biomethane injection facilities in France

3.1. Characteristics of the connected fleet

Distribution of total installed maximum capacity[10] by type of injection site as of 31/12/2017

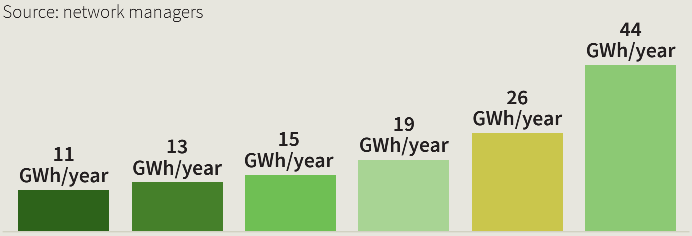
Source: network managers



- Autonomous agriculture
  17 sites · 181 GWh/year · 27%
- Territorial agriculture
  12 sites · 160 GWh/year · 23%
- Sewage sludge
  7 sites · 108 GWh/year · 16%
- Household waste and biowaste
  4 sites · 106 GWh/year · 16%
- Territorial industry
  2 sites · 89 GWh/year · 13%
- Storage facilities for non-hazardous waste (SFNHW)
  2 sites · 38 GWh/year · 6%

Average size of biomethane injection installations according to the nature of the facility, expressed in maximum production capacity[10].

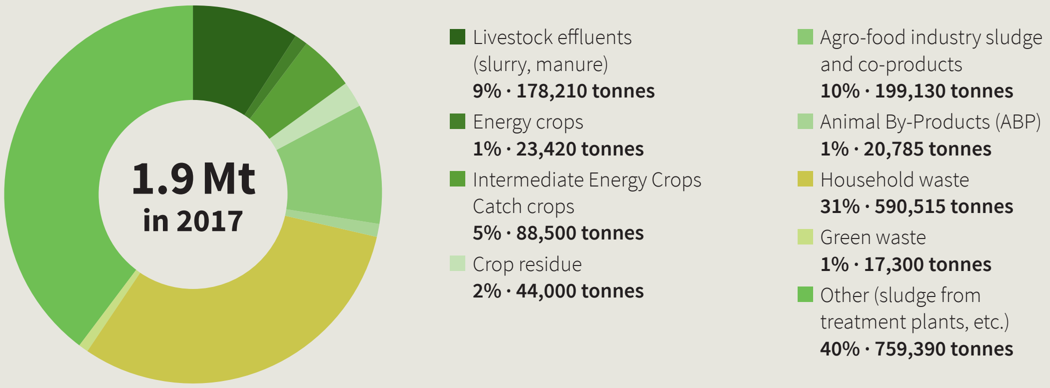
Source: network managers



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

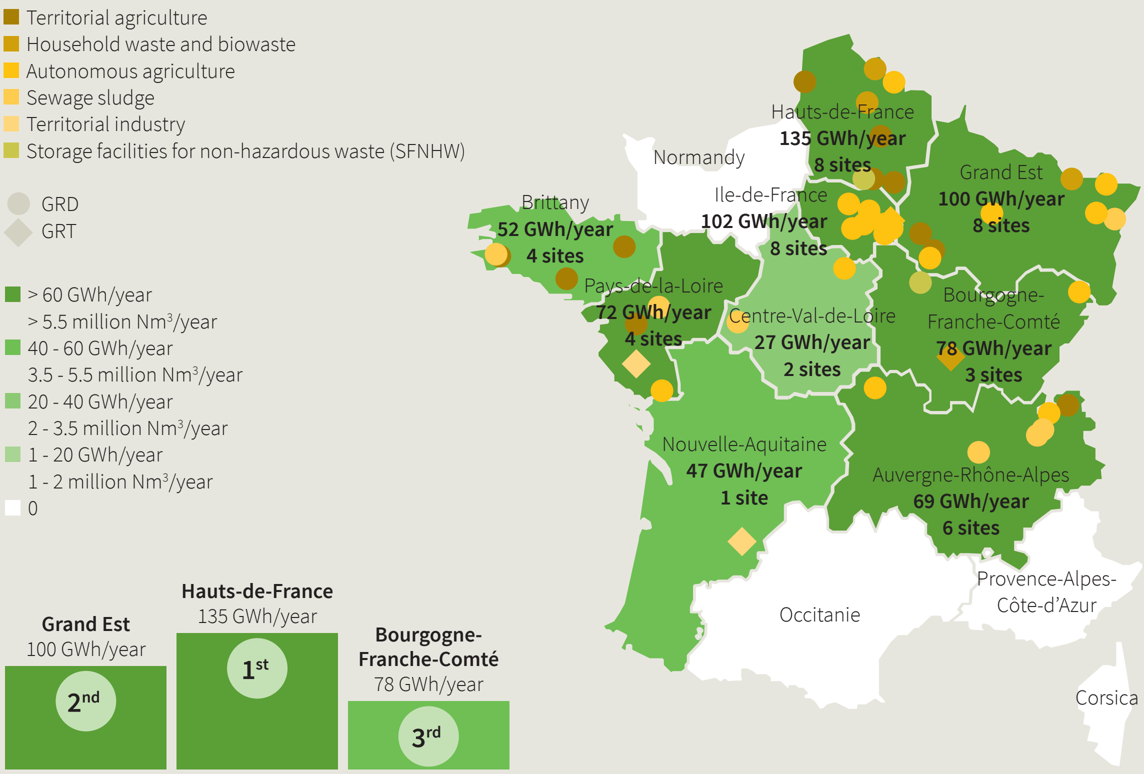
10. The maximum production capacity expressed in TWh/year was calculated based on the following assumptions: maximum capacity, Cmax, extracted from the capacity register expressed in $m^3(n)/h$, HHV = 10.9 $kWh/m^3(n)$ and 8,200 hours of annual operation.

Types of inputs used in injection units in France in 2017
Source: ADEME



3.2. Regional distribution of farms

Regional distribution of maximum capacity[12] installed per rate band as of 31/12/2017
2017 regional record in terms of installed capacity
Source: gas network operators



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.

WHAT IS A NORMO CUBIC METER? Nm^3 or $m^3(n)$

Normal cubic metres are units of measurement for gas quantity. They correspond to the contents of a volume of one cubic metre, for gas under normal conditions of temperature and pressure.

The heating value of biomethane corresponds to the amount of energy contained in an Nm^3 of this gas.

There is a difference in the Higher Heating Value (HHV), in kWh/Nm^3, between geographical areas with high heating value known as “H zones” and those areas with low heating value, called “B zones” (in northern France fed by Gaz de Groningen) of around 10%.

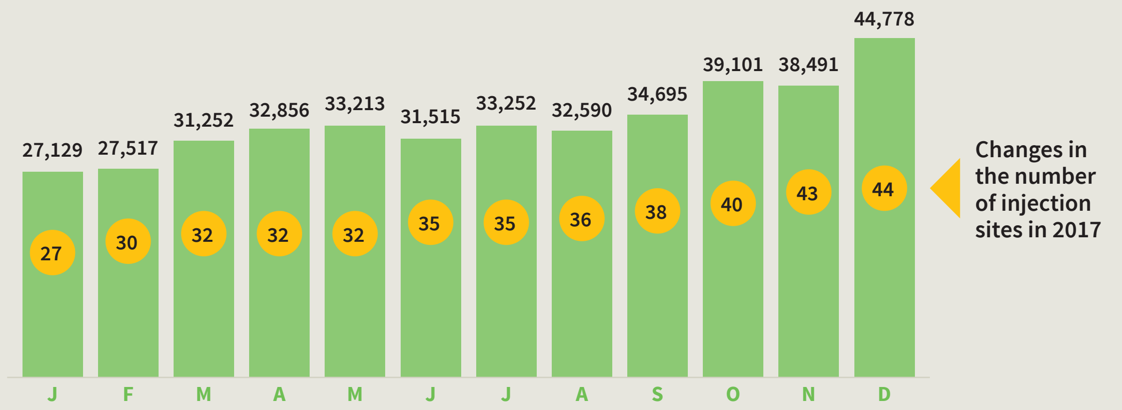
So, the average HHV of biomethane obtained in zone H is 10.9 kWh/Nm^3 and the average HHV obtained in zone B is 9.8 kWh/Nm^3

Source: network operators

3.3. Production of facilities

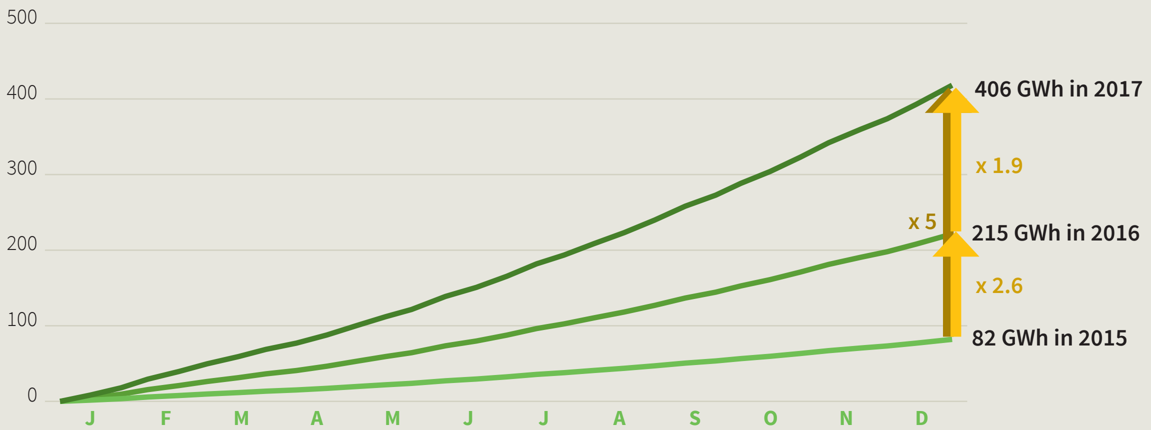
Monthly productions of biomethane injection installations for 2017 (MWh)

Source: gas network operators



Cumulative production of existing installations in GWh (0°)

Source: gas network operators



4. Growth prospects for the sector

4.1. Growth momentum confirmed in 2017

→ 361 PROJECTS REGISTERED IN THE CAPACITY REGISTER

As part of managing biomethane injection capacities, it was decided to create a registry 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.

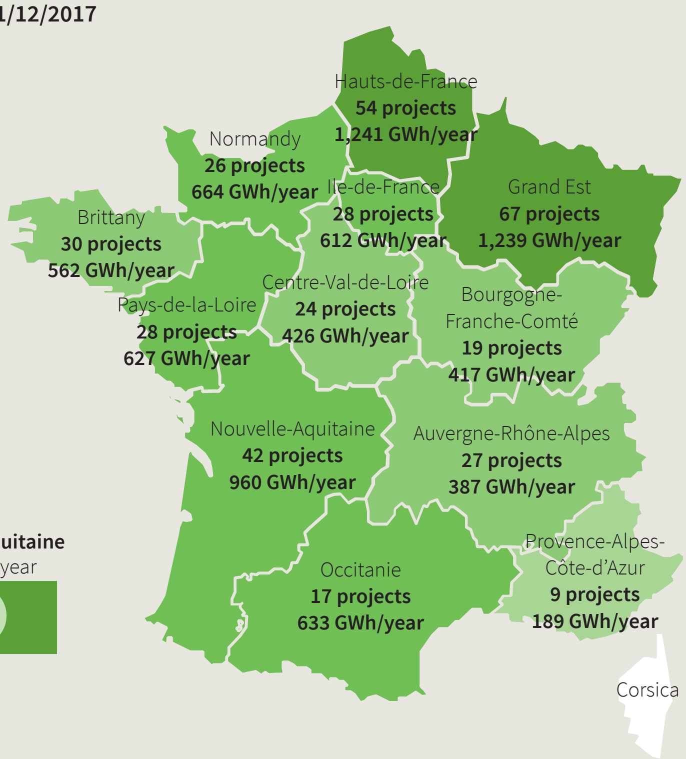
The capacity register (or queue) is common for transmission and distribution system operators. It allows projects to enter according to their order of arrival with a number allocation, which will allow, if necessary, allocations of injection capacity to be prioritised. GRTgaz and Teréga have been appointed as managers of the capacity management registry by decision of the Energy Regulatory Commission (CRE) dated April 2014.

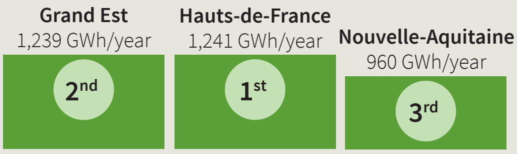
► **THE 361 PROJECTS IDENTIFIED AT THE END OF 2017 THEMSELVES REPRESENT 8 TWh/year OF BIOMETHANE INJECTION. THIS MEETS THE OBJECTIVE SET BY THE PPE FOR 2023. IT IS EQUIVALENT TO THE AVERAGE ANNUAL CONSUMPTION OF 663,000 CUSTOMERS OR 35,000 BUSES OR LORRIES RUNNING ON BIO-NGV.**

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.

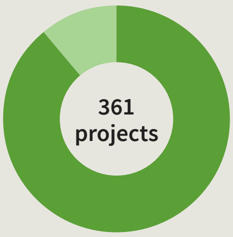
Regional distribution of maximum capacity[12] of queued biomethane injection projects as of 31/12/2017
Source: GRTgaz and Teréga

- > 1,000 GWh/year
  > 92 million Nm³/year
- 600 - 1,000 GWh/year
  55 - 92 million Nm³/year
- 300 - 600 GWh/year
  28 - 55 million Nm³/year
- 1 - 300 GWh/year
  0.1 - 28 million Nm³/year
- 0





Number of projects by network type



- Distribution 90 %
- Transmission 10 %

Capacity reserved for production by network type

- Distribution 82 %
- Transmission 18 %

4.2. Development of the network architecture

In an effort to expand the natural gas network capacity, operators are developing solutions to address constraints and maximise the volumes being injected:

- distribution network meshing;
- additional market opportunities by developping gas end-use, bioNGV;
- carried injection, i.e. transport and injection of biomethane into another network grid;
- biomethane storage.

Network operators are also conducting experiments to enable gas to be fed into higher-pressure stages in order to access wider consumption areas. This is called reverse flow installations. The network thus becomes bidirectional.

WEST GRID SYNERGY

A number of network operators launched the West Grid Synergy project in 2017, which relates to reverse flow installation experiments. This involves two pilot backfeeding units at the interface between the distribution and transport networks in the community of the communes of Pontivy in Morbihan and Pouzauges in Vendée.

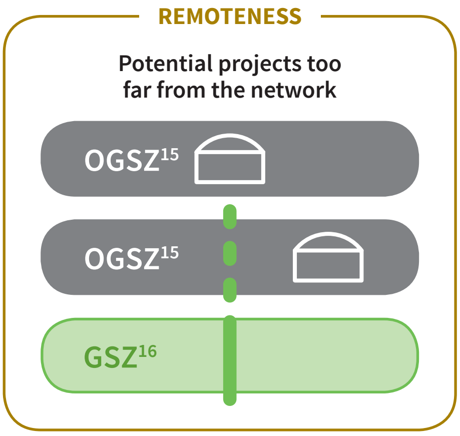
The West Grid Synergy project will make it possible to define technical and economic conditions for reverse flow installations between the distribution and transmission networks. The experiments are anticipated to start at the end of 2019.

A distribution/distribution reverse flow installations project will be implemented in parallel in the Troyes region.

The three areas of experimentation (Pouzauges, Pontivy, Troyes) also constitute laboratories for defining methods of adapting and piloting the networks of tomorrow. GRTgaz estimates that 150 distribution/transport backfeeding units will be necessary to accommodate over 50 TWh biomethane in 2028.

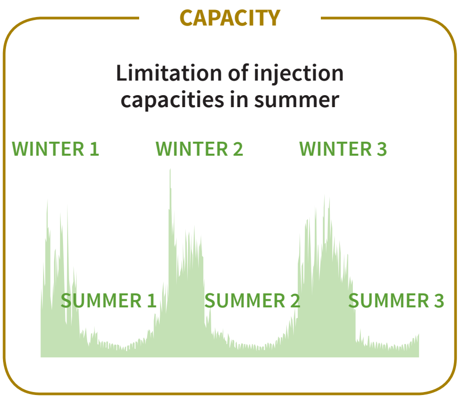
GRDF has already identified about 15 distribution/transport backfeeding units, which are set to be brought into operation by 2020-2021 and will allow for the creation of new renewable gas injection projects.

In the coming years, and in order to go further than simply allocating existing capacity, network operators would like to set up new mechanisms for the development of capacity for receiving renewable energy sources on gas networks. Some existing producers could reduce their summer shaving when subjected to them. Above all, these network developments would offer an opportunity to accept as many new projects as possible and limit the risk perceived by investors in order to ensure the financing of the sector. The achievement of the renewable gas development objectives set by the State must pass through these new tools.



ANTICIPATION OF NETWORK INVESTMENT

- CONNECTION OF THE NETWORK TO BIOMETHANE RESOURCES, PARTICULARLY FROM AGRICULTURAL ORIGIN
- IMPLEMENTATION OF POOLED NETWORK INFRASTRUCTURE TO COLLECT BIOMETHANE



REVERSE FLOW

- COMPRESSION OF GAS BY INNOVATIVE STATIONS TO ALLOW IT TO GO OPPOSITE THE TRADITIONAL DIRECTION OF FLOW
- 3 PILOT SITES BY 2019

15. OGSZ: Outside Gas-Served Zone
16. GSZ: Gas-Served Zone

Although today reverse flow installations is identified in response to a declared need, in the future it will have to go through network development planning in order to anticipate and optimise investment in gas networks and offer the necessary visibility to project owners.

To do this, network operators have begun working on master plans by defining the accommodation capacities of gas networks in response to the renewable gas production potential identified during consultation of stakeholders at the local level.

4.3. Perspectives: 2028-2030

Biomethane, derived from anaerobic digestion, is the first, now 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 and SRF (Solid Recovered Fuels);
- 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;
- valorization of microalgae.

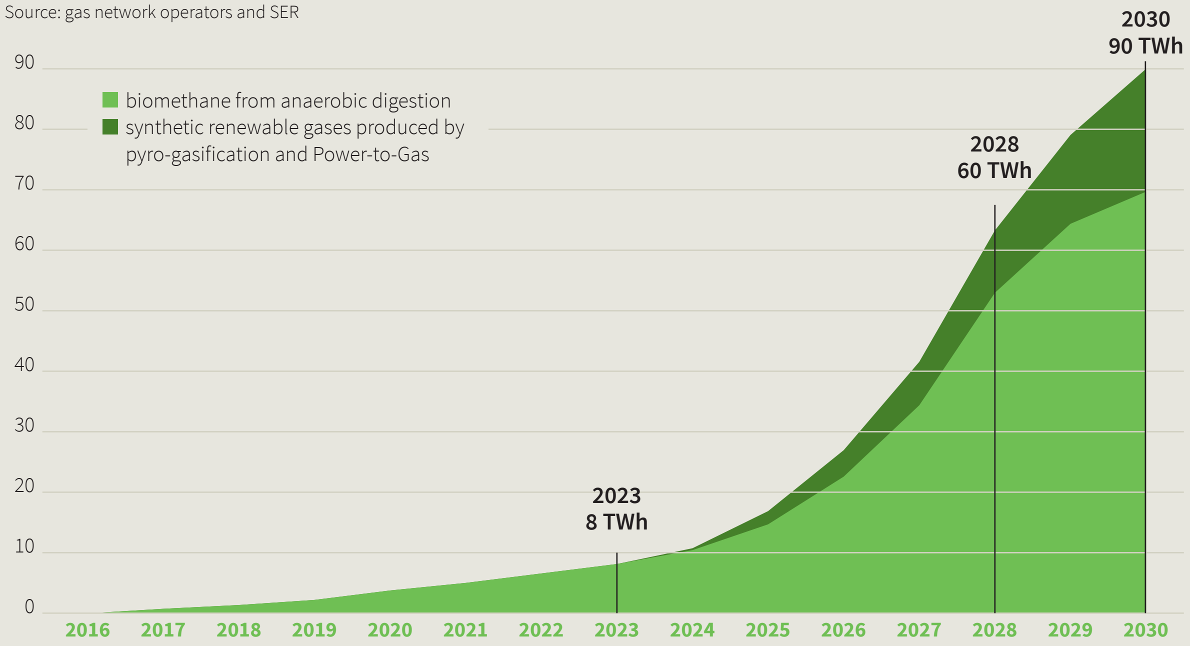
2017 was marked by the launch of discussions for PPE's 2028 objectives. On 19 October 2017, network operators and SER shared a common ambition for 2030: to triple the 10% objective of the 2015 Energy Transition Act for Green Growth. For the next PPE, this means an objective of over 50 TWh by 2028. For mobility, which is one of the flagship uses of biomethane, the objective may therefore be revised upwards: to reach 30% Bio-NGV in the NGV share in 2028.

This ambition may be summed up in two objectives:

- ▶ **60 TWh** of renewable gas **in 2028**, including **50 TWh** of biomethane
- ▶ **90 TWh** of renewable gas **in 2030**, including **70 TWh** of biomethane

2030: 30% renewable gas in networks

Source: gas network operators and SER



→ WHY IS THIS AMBITION REALISTIC?

BIOMETHANE PRODUCED BY ANAEROBIC DIGESTION:

The 50 TWh objective for biomethane in 2028 is consistent with the trend observed in the capacity reservations (over 350 projects have already reserved injection capacity in networks for the start of 2018 and already account for 8 TWh by 2023). Studies carried out and the resulting estimates show significant potential for renewable gas production: based on mobilisation rates between 10 and 67%, the main inputs are intermediate crops, agricultural residues, grasses and silage[17]. This potential in particular is a key for account intermediate crops that form part of the development of agro-ecology.

On the network side, there are already identified technical solutions to allow the injection of the corresponding biomethane volumes (implementation of reverse flow installation, meshing, etc.) and their implementation would entail a very modest cost increase (estimated at 2% of the total cost). However, it depends on the adaptation of the current regulatory framework to facilitate the connection of agricultural sites.

Partakers, in the biomethane sector – in particular in the agricultural field – are organising themselves to continue and reinforce its professionnalisation and support project owners. It applies in particular by sharing best practices and capitalising on the operational / maintenance know-how of existing units.

Finally, the high increase of the number of units will enable equipment manufacturers to organise themselves to improve the quality of the necessary products and services for biomethane installations from 2023 onwards.

An ENEA study[18] brought about reflections on ways to reduce costs in the sector, potentially by up to around 30%. According to this study, a significant proportion corresponds to the reduction of the Capex of facilities.

→ WHY IS THIS AMBITION BENEFICIAL?

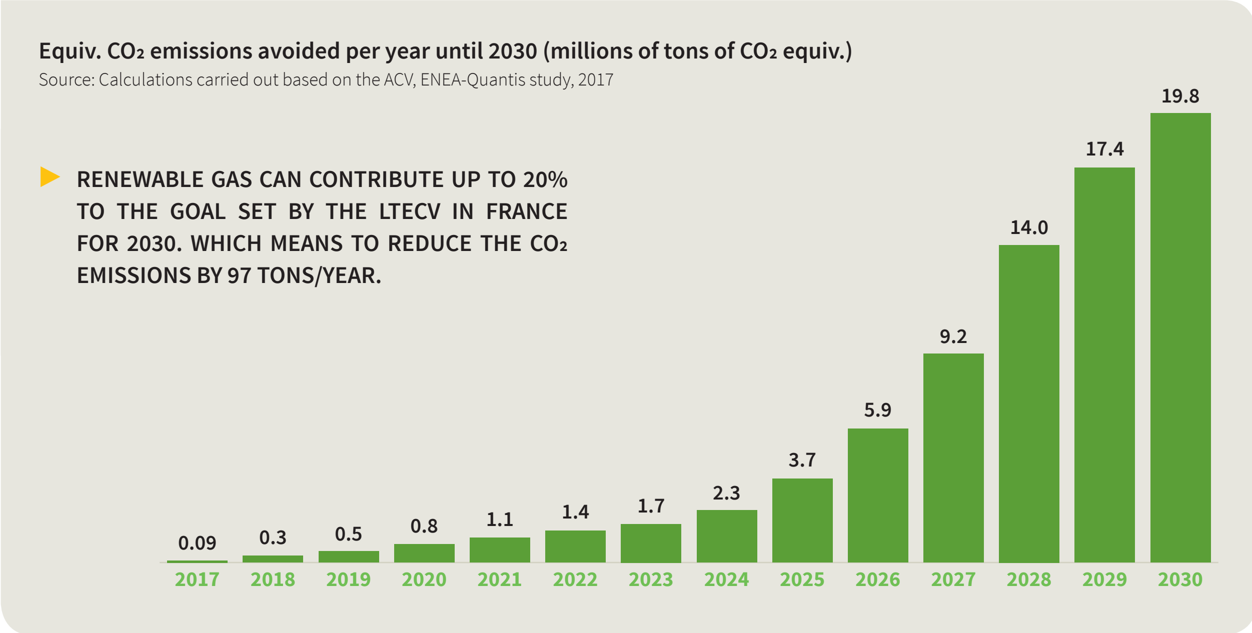
Accelerating the development of the biomethane industry will help to accelerate the decarbonation of several sectors of activity, considering the diversity of uses that can be made of biomethane (heating, hot water, cooking, mobility).

By 2030, the renewable gas sector should thus make it possible to avoid the emission of almost 20 million tonnes of CO_2 equiv./year.

Biomethane also helps to fulfil an ambition of securing sustainable agriculture in regions. A tool for the circular economy and energy independence of regions, the sector is already having positive local impacts demonstrated by the current trend:

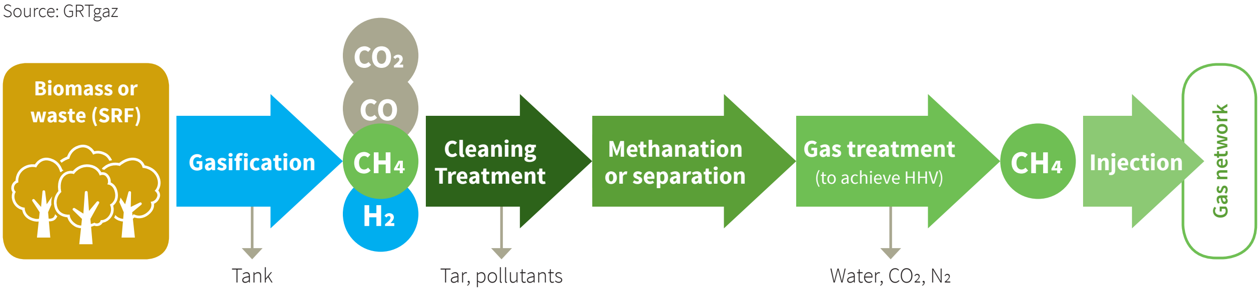
- **Economic impacts through the diversification and securing of local revenue:** use of local resources, creation of non-relocatable jobs (3-4 jobs per site for operations), additional revenue for biomethane project owners, savings in the purchasing of chemical fertilisers replaced by organic fertilisers such as digestate. Accessible resources being over 90% agricultural, it is estimated that 15% of farmers (nearly 50,000) could be involved. Largely comprised of French companies (including numerous SMEs and VSEs), in France the sector retains 75% of the value created with a significant impact on the French industrial sector (incorporators, civil engineering, maintenance). An ambitious anaerobic digestion plan would also help to restore the balance of trade of fossil hydrocarbons in France (an economy estimated at between 1 to 2 billion euros for a 50 TWh reduction in imports of natural gas).
- **Ecological impacts with promotion of a sustainable method of agriculture:** beyond greenhouse gas reduction, anaerobic digestion makes it possible to reduce chemical fertiliser consumption thanks to the use of digestates, and encourage the development of intermediary crops. Digestate, a co-product of anaerobic digestion, offers better nitrogen management compared with chemical fertilisers: anaerobic digestion converts organic matter containing nitrogen in a complex form – which cannot be used by plants – into digestates containing nitrogen in a soluble form, which is directly assimilable by roots. Intermediary crops take up nitrogen from the soil, thus avoiding its leaching, which promotes storage of carbon. Harvesting them for biogas production is therefore an additional benefit.

17. “100% renewable gas in 2050 study”, ADEME / GRDF / GRTgaz
18. “Overview of the biomethane sector in France and ideas for its development”, ENEA, 2017



→ PYRO-GASIFICATION OF BIOMASS AND SRF

The pyro-gasification process
Source: GRTgaz



SYNTHETIC GAS FROM PYRO-GASIFICATION LOOKS PROMISING

Pyro-gasification, a high-temperature thermochemical process, is used to obtain synthetic gas (syngas) from renewable raw matter. The syngas produced is then treated with a view to producing electricity and/or heat, or renewable gases such as synthetic biomethane, or even renewable hydrogen that is injectable into networks for the traditional uses of natural gas and fuel.

Pyro-gasification processes, which vary greatly to anaerobic digestion processes, can provide innovative, efficient and additional solutions for anaerobic digestion. They can be used to optimise energy recovery of different biomasses and waste products, which cannot currently be recovered in the form of materials or they are difficult to treat.

In addition to the many technical and environmental advantages of the pyrolysis and gasification processes, the "injection into networks" 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.);
- propose an alternative to the production of electricity and heat, with more attractive yields, liberating them of any seasonal heat-removal constraints, and adapting the facilities to input volumes available in the regions;
- help to optimise regional waste management policies with the energy recovery of SRF (Solid Recovered Fuels), but with increased energy efficiency and significantly lower atmospheric emissions than incineration;
- help develop a circular economy and produce renewable energy in regions (or recovery for SRF) at a price that can be controlled, thus improving France's energy independence.

This sector, the first projects in the pyro-gasification industry are expected to start around 2020, will thus effectively supplement the quantities of renewable gases expected from production by means of anaerobic digestion. Resource studies show that the potential is significant: almost 140 TWh renewable gas in 2050[17].

The issue today is confirming the first pilot projects in terms of technical feasibility and strengthening data for the economic model thanks to the demonstration projects.

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

▸ GAYA, THE FIRST DEMONSTRATOR IN FRANCE

This project, called GAYA, whose platform was inaugurated in October 2017 in Saint-Fons (Auvergne-Rhône-Alpes), in the Vallée de la Chimie, is developing an innovative demonstration chain across the entire supply chain (gasification, methanation, synthetic gas treatment and biomethane production). GAYA will make it possible to confirm technical data on performance and life-cycle analysis. About 20 engineers and technicians are required to work on the site.

The GAYA project, launched in 2010 by Engie, unites 11 partners with complementary expertise and represents an investment of €60M, financially supported by ADEME to the tune of €19M.

gaya

Gaya Project Platform

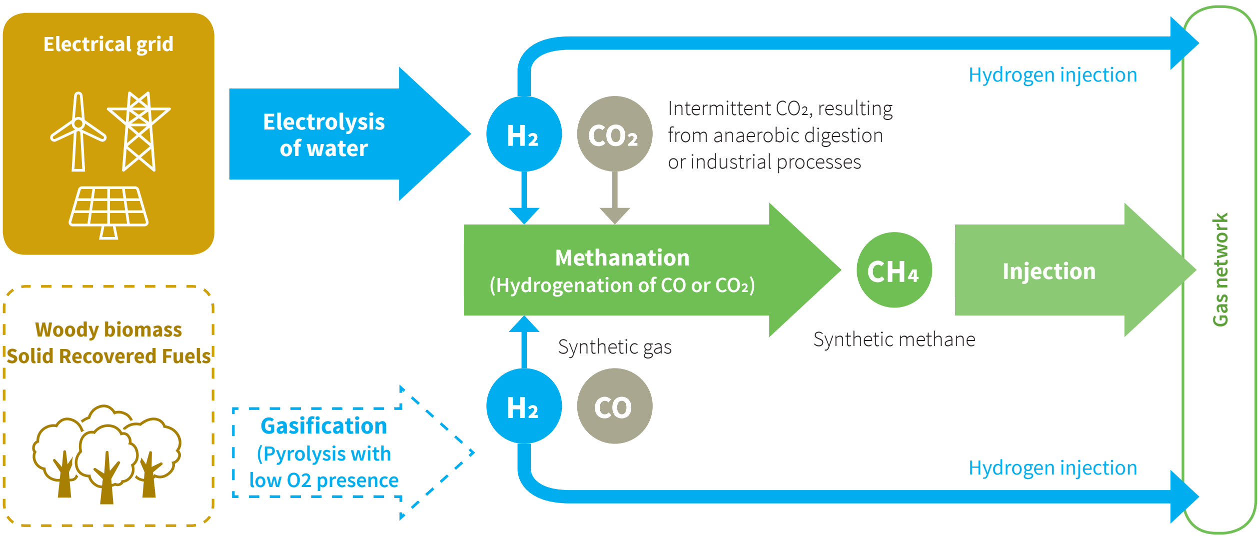
Source: Biomethane from gasification - production potential in France by 2020 and 2050, GRDF
Study conducted by GDF SUEZ and co-managed by ADEME, MEDDE, MINEFI & MAAF, February 2013

→ POWER-TO-GAS: A NEW TOOL FOR RENEWABLE ELECTRICITY

Power-to-Gas is a new tool that is particularly relevant for supporting the massive deployment of renewable electricity and enhancing its production. During periods of abundant power, Power-to-Gas transforms surplus electricity into hydrogen by electrolysis of water.

This hydrogen can then be injected into the natural gas network:

- either as it is;
- or after being converted to synthetic methane by associating it with CO_2 by methanation.



17. "100% renewable gas in 2050 study", ADEME / GRDF / GRTgaz

However, Power-to-Gas coupled with network injection means that advantage can be taken of the significant storage capacities of the gas infrastructure (transit stock and underground storage). Indeed, at this time, prospective studies foresee large and long-term production surpluses (> 1 day) that cannot be managed using "conventional" electrical storage solutions (treatment plants, batteries). Storage is now regarded as one of the major challenges facing renewable electricity for energy transition to succeed. Power-to-Gas therefore provides an additional solution of flexibility for the electrical grid and allows for better integration of renewable electricity.

While the interest of Power-to-Gas is proven for 2030 by prospective studies[19], its technical feasibility and economic model remain to be established. This is the objective of several demonstration projects supported by stakeholders in the European sector, as well as in France.

▶ RENEWABLE HYDROGEN INJECTION INTO NETWORKS

The possibility of injecting renewable hydrogen into the gas networks gives direct access to its very large transport and storage capacities: in France, gas storage capacity is 300 times greater than that of the electrical grid (137 TWh compared with 0.4 TWh)[17]. Nowadays, the percentage of hydrogen injectable into networks mixed with natural gas is the subject of research and demonstrators by network operators in order to remove uncertainties relating to safety and compatibility with networks. For example, the GRHYD project tests the levels of 6-20% hydrogen injected into the distribution network.

▶ CONVERSION OF RENEWABLE HYDROGEN TO SYNTHETIC METHANE BY METHANATION

Methanation represents an additional step that combines renewable hydrogen with carbon dioxide (CO_2) to form synthetic methane (CH_4), 100% miscible with natural gas. There are numerous possible carbon dioxide sources: recovery of CO_2 after biogas or syngas purification (gasification of biomass), capturing CO_2 from industrial emissions (cement, petrochemical, as well as all combustion equipment) and emissions linked with electricity production.

▶ DEMONSTRATOR PROJECTS

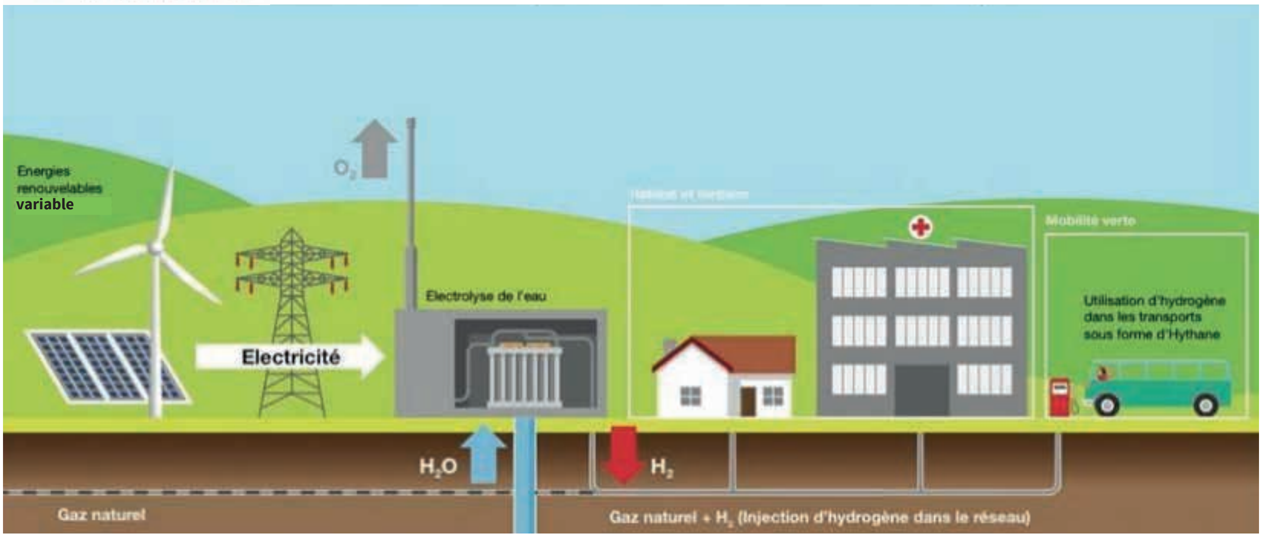
As part of the "Hydrogen Regions" call for tenders launched in early 2016 by the Ministry of Energy, several methanation and synthetic methane injection demonstration projects into the natural gas networks have emerged. Some of these concern the valuation of fatal industrial gases (hydrogen, carbon dioxide), while others highlight synergies with anaerobic digestion, recovering the CO_2 released during the biogas purification phase. These projects could each inject 20 to 150 Nm^3/h into natural gas networks by 2018-2020. They will be carried out by consortia that bring industrialists and local authorities together; they will make it possible to check the technical and economic viability of such processes.

19. "PEPS - Study of energy storage installation potential", ADEME / ATEE / ARTELYS / DGCIS / ENEA Consulting / G2ELab, November 2013
17. "100% renewable gas in 2050 study", ADEME / GRDF / GRTgaz

▸ THE GRHYD DEMONSTRATOR

The GRHYD project is the first Power-to-Gas demonstration project in France. It consists of two batches: the first batch piloted by GRDF will test the injection of a variable part of hydrogen into a natural gas distribution island for a new district of Cappelle-la-Grande in the Urban Community of Dunkirk. Its objective is to measure the technical feasibility and to evaluate the economic relevance of hydrogen injection into the natural gas distribution network in order to increase renewable electricity produced outside of consumption periods through natural gas uses (heating, domestic hot water, fuel). The proportion of hydrogen injected to be tested in the demonstrator ranges from 6 to 20% (by volume). The hydrogen-natural gas mixture will supply a new neighbourhood of about 100 dwellings (collective and individual) as well as the heating system of a tertiary facility. Hydrogen injection is expected to start in June 2018. The second batch is designed to test Hythane® fuel (mixture of natural gas & hydrogen) on a fleet of buses.

GRHYD project outline



▸ THE JUPITER 1000 DEMONSTRATOR

In addition, GRTgaz and seven partners (including Teréga) launched a Power-to-Gas demonstration project with the production of hydrogen and synthetic biomethane by means of methanation, called "Jupiter 1000", which is located in Fos-sur-Mer. Connected to the gas transmission network, this synthetic biomethane production site aims to increase the surplus value of renewable electricity and recycle the CO_2 captured at a neighbouring industrial site. It will also test the direct injection of hydrogen, this time on transport networks. The first injections are planned for 2018. This will be the first Power-to-Gas installation in the transport network on this scale in France. The Jupiter 1000 project is co-financed by the European Union as part of the FEDER fund, by the State as part of the "investissements d'Avenir" [Future Investments] programme entrusted to ADEME and the Provence-Alpes-Côtes d'Azur Region. This project has also been certified by the Capénergies competitiveness cluster.

Modelling the Jupiter 1000 project

→ ARE WE MOVING TOWARDS 100% RENEWABLE GAS IN 2050?

http://www.ademe.fr/mix-gaz-100-renouvelable-2050

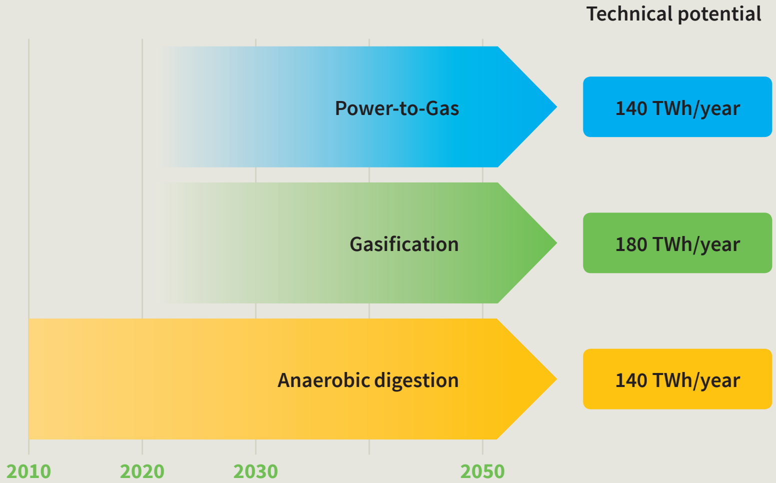
Forecasting was conducted by ADEME, with the participation of GRDF and GRTgaz, in order to define the necessary technical and economic conditions to achieve 100% renewable gas. The main production channels analysed are biomass anaerobic digestion, the pyro-gasification of biomass or SRF (Solid Recovered Fuels), methanation of hydrogen produced from renewable electricity or electricity of industrial origin, and hydrogen injection blended in natural gas.

The work was based on the ADEME 2035-2050 energy scenario, with a level of final demand for gas in 2050 of about 300 TWh compared with 460 TWh today.

The results, based on sensitivity analyses and various scenarios of renewable gas production mixes, show that there are the theoretical potential renewable-gas resources to meet an energy demand of about 300 TWh in 2050. This will require minor changes to the actual gas network and especially the development of complementarity between the gas and electric networks.

Technical potential of injectable renewable gases by 2050

Sources: "Towards 100% renewable gas ", ADEME, GRDF, GRTgaz



Introduction to stakeholders

As France's leading natural gas distributor, GRDF operates and develops the natural gas distribution network in more than 9,500 communes. Owned by the communities, 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 registering guarantees of origin since December 2012.

GRTgaz is one of the largest natural gas transporters in Europe and is a world expert in gas-transport systems and networks. In France, GRTgaz owns and operates 32,400 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 carries out public service duties in order to guarantee that supply to consumers continues and the it also markets transport services to network users. 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, which are fully involved in energy transition.

There are 380 members in the French Syndicate for Renewable Energies and it represents a turnover of 10 billion euros and more than 100,000 jobs. This professional union connects those involved in renewable energy sectors: biomass (EBF Commission), wood energy, biofuels, biogas, wind power, renewable marine energies, geothermal energy, hydroelectricity, heat pumps, photovoltaic energy (SOLER), solar thermal energy and thermodynamics. Its missions are to promote renewable energy and to defend the interests of professionals in the sector by developing dynamic and sustainable industrial sectors.

Teréga acts to make the future of gas visible today, by becoming an accelerator of the energy transition and a major contributor in tomorrow's energy model. Historically located in the South-West region, an intersection for the major European gas flows, Teréga has been deploying its exceptional expertise in transport and gas-storage infrastructure development for over 70 years, today allowing it to design new solutions to meet French and European energy challenges. The company has over 5,000 km piping and 2 underground storage sites, which respectively represent 16% of the French gas transport network and 24% of national storage capacity. In 2016, it generated a turnover of €467M and had over 580 employees. Meeting its public service obligations, Teréga also ensures the transport of natural gas to over 400 delivery substations, under the best safety, cost and reliability conditions.

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SPEGNN - Syndicat Professionnel des Entreprises Gazières municipales et assimilées www.spegnn.com
Teréga Société Anonyme with a capital of €17,579,088 / RCS Pau 095 580 841 / www.terega.fr

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