Air Liquide, from biogas purification to bio-NGV for transport
Drawing the contours of the energies of tomorrow

Air Liquide is helping to draw the contours of the energies of tomorrow and seeks to introduce scientific and technological innovations into society that will open up new markets while addressing today’s economic and environmental challenges.

In a world where energy needs and sources are changing rapidly, the ability to transform organic resources into renewable and totally carbon-free energy is poised to become part of the new energy mix. The energy produced in this way offers the advantage of being easy to store and responsive to the need for sustainable heating and clean transportation in modern societies.

To this end, Air Liquide is actively working to develop biogas purification as well as hydrogen energy. The Group is thus present across the bio-NGV chain: production from organic and farm wastes, purification, liquefaction, packaging, transportation and distribution. Air Liquide is in a position to gain a better understanding of new consumer uses in the area of clean transportation, today with the distribution of bio-NGV, tomorrow with hydrogen energy.
Air Liquide rises to the challenge of clean energies

What exactly is biogas?

Biogas is a renewable energy produced during the methanization of biomass. Composed primarily of methane and carbon dioxide (CO₂), biogas is efficiently upgraded to biomethane through purification. Biomethane, which is a virtuous form of energy, can replace natural gas.

What is methanization?

Methanation consists of treating biologically various types of organic matter – whether derived from farming or not – in anaerobic conditions (without oxygen). The phenomenon of methanation occurs naturally in swamps, spontaneously in waste dumps, or is artificially provoked in anaerobic digesters (also called methanizers), during the treatment of household waste, industrial or agricultural waste or sludge (also known as slurry).

Air Liquide works with a variety of partners to transform waste products into biogas.

To upgrade biogas

Focused on the challenges and the dynamic of new energies, Air Liquide advanced Business & Technologies embodies the ambition of the Air Liquide group, developing global solutions for the biogas upgrading. Thanks to the development of several technological bricks, including the membranes technologies which separate CO₂, these solutions enable:

- the upgrading of all biogases for subsequent injection into the natural gas grid,
- the production of vehicle fuel (compressed or liquefied bio-Natural Gas for vehicles),
- the production of renewable hydrogen from liquid biomethane.

The Air Liquide group’s recognized expertise in the area of industrial gases, combined with its experience in biogas purification, constitutes a major strength.
Air Liquide rises to the challenge of clean energies

Present across the whole biogas value chain
From biogas to biomethane

How is biogas upgraded into biomethane?

Through a process of purification:

What are the advantages of purifying biogas into biomethane?

- It offers **better energy conversion efficiency** that is also eco-friendly,
- It is an **economically profitable** upgrading process,
- The technology behind the process is **simple to implement**.
Biogas purification technology

Membrane purification

Air Liquide’s purification modules are able to separate methane and carbon dioxide using an innovative process involving polymeric membranes manufactured by Air Liquide (Medal*). This efficient system generates high quality biomethane with methane content between 96.5% and 99%. Combined with a vent stack treatment unit, the biogas is fully upgraded.

What are the advantages of this technology?

- It guarantees optimal quality for injection into the network
- Its extraction rate exceeds 98% (up to 99.5% according to the configuration)
- It is energy efficient and environmentally sound
- It is a simple and reliable system (installation available at 98%)
- It is efficient and cost effective

* Medal is an Air Liquide group company affiliated with Air Liquide advanced Technologies United States.
The liquefaction of biomethane

Why biomethane liquefaction?

*Because liquefaction opens up other avenues for biomethane upgrading.*

Indeed, the liquefaction of biomethane appears to offer an effective solution for the logistical constraints that arise in the absence of a transportation network. In its liquid form, biomethane is easily transportable to its point of use. It can then be upgraded.

Air Liquide provides industrial liquefaction units which controlled technology is adapted to the needs of its clients. Liquefaction is reliable and high-performing process that enables optimized energy consumption.
From biomethane to bio-Natural Gas for Vehicle (bio-NGV)

Biomethane in transportation

The biomethane that is upgraded by Air Liquide is used as fuel and referred to as bio-Natural Gas for Vehicles (bio-NGV). This bio-NGV takes two forms:

- CNG (Compressed Natural Gas). This fuel supplies stations for captive light vehicle fleets, cars, semi-trucks, vans, buses.
- LNG (Liquefied Natural Gas). Easily and safely transportable, this fuel supplies stations for semi-trucks, touring buses.

The biomethane is also used in the production of hydrogen (decarbonized hydrogen for use in hydrogen-powered vehicles, in Air Liquide commitment for Blue Hydrogen).

A solution for clean transportation

The issues of climate change and the energy transition have been in the headlines for several years. The public has woken up to the need to shift to a new energy mix, where clean and renewable energies will have their place. Air Liquide is aware of these issues and is working actively to bring about clean transportation. Present across the biomethane value chain, Air Liquide supports the circular economy, from waste to transportation. Bio-NGV enables the shift to renewable gas fuels and away from liquid fossil fuels, paving the way for hydrogen mobility. This in turn will significantly reduce the carbon footprint of vehicles, offering an efficient response to the major challenges facing society in the areas of human health and protection of the environment.

Air Liquide develops a network of clean multi-energies stations in France and in the United Kingdom dedicated to road freight transport. A clean multi-energies station distributes several types of gas for vehicles: compressed natural gas (CNG), liquefied natural gas (LNG) and liquid nitrogen (LN₂). Trucks with urban and interurban delivery routes can run on CNG and LNG. Trucks with cryogenic refrigeration units need liquid nitrogen for the refrigerated transportation of foodstuffs, in particular in urban areas (Air Liquide's Blueeze Solution). To date, Air Liquide operates 10 clean multi-energies stations: 7 in France and 3 in the United Kingdom.
Air Liquide pursues its business development in the Scandinavian biogas market with acquisitions firmly aligned with its aim of harnessing renewables technology for clean transport.

About FordonsGas

Founded in 1998 in Sweden, FordonsGas (Air Liquide’s subsidiary) distributes bio-Natural Gas for Vehicles (bio-NGV) for the Swedish transportation market. FordonsGas owns and operates more than 50 bio-NGV stations, making it one of the largest distribution networks for this alternative fuel on Swedish territory. The filling stations operated by FordonsGas enable taxis, corporate vehicle fleets, buses, and passenger cars to acquire fuel that is more environmentally friendly, nearly 70% is produced from renewable energies. Air Liquide supplies its gas liquefaction technologies to FordonsGas, one of the world’s largest facilities for bio-NGV production and completes the Group’s positioning in this market.

About Skagerak Naturgass

Founded in 2002 in Norway, Skagerak Naturgass (subsidiary of Skagerak Energi) is part Statkraft group, Europe’s largest generator of renewable energy. Skagerak Naturgass runs a distribution network delivering renewable natural gas to industry and 100% biomethane to the Norwegian transport sector through 4 bio-GNV stations (bio-CNG/LNG) operated in the Oslo region which are currently used for fueling trucks and buses. Skagerak Naturgass occupies a unique position in Norway, operating a distribution network and biomethane filling stations serving one customer base, in parallel by getting their biogas from local businesses specialized in organic waste recovery. The Group has chosen to partner with Skagerak Energi to develop its activities related to the biogas and biomethane market in Norway. Air Liquide announced its acquisition of a majority equity in the company in 2017.
Global references

Key figures

- 50 biogas sites worldwide
- Near 60 GNV stations in Europe

Locations

- United-States
- Brazil
- Chile
- Germany
- Austria
- France
- United-Kingdom
- Sweden
- Norway
- China
Key figures

AIR LIQUIDE AND BIOGAS

- Nearly 50 biogas sites worldwide
- Nearly 60 bio-NGV filling stations in Europe
- More than 30 years of experience in membrane production
- More than 100 years of experience in gas separation
- Air Liquide, world leader in biogas purification, with a capacity of 160,000 m³/h

THE AIR LIQUIDE GROUP

- The world leader in gases, technologies and services for Industry and Health
- Present in 80 countries
- Approximately 65,000 employees
- More than 3 million customers and patients
- 9 Research and Development sites, 15 main Engineering centers
- Around 300 patents per year
- 2016 Revenue: €18,135 million
- 2016 Net profit: €1,844 million
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