Pietro Fiorentini

BIOGAS & BIOMETHANE

Solutions & references

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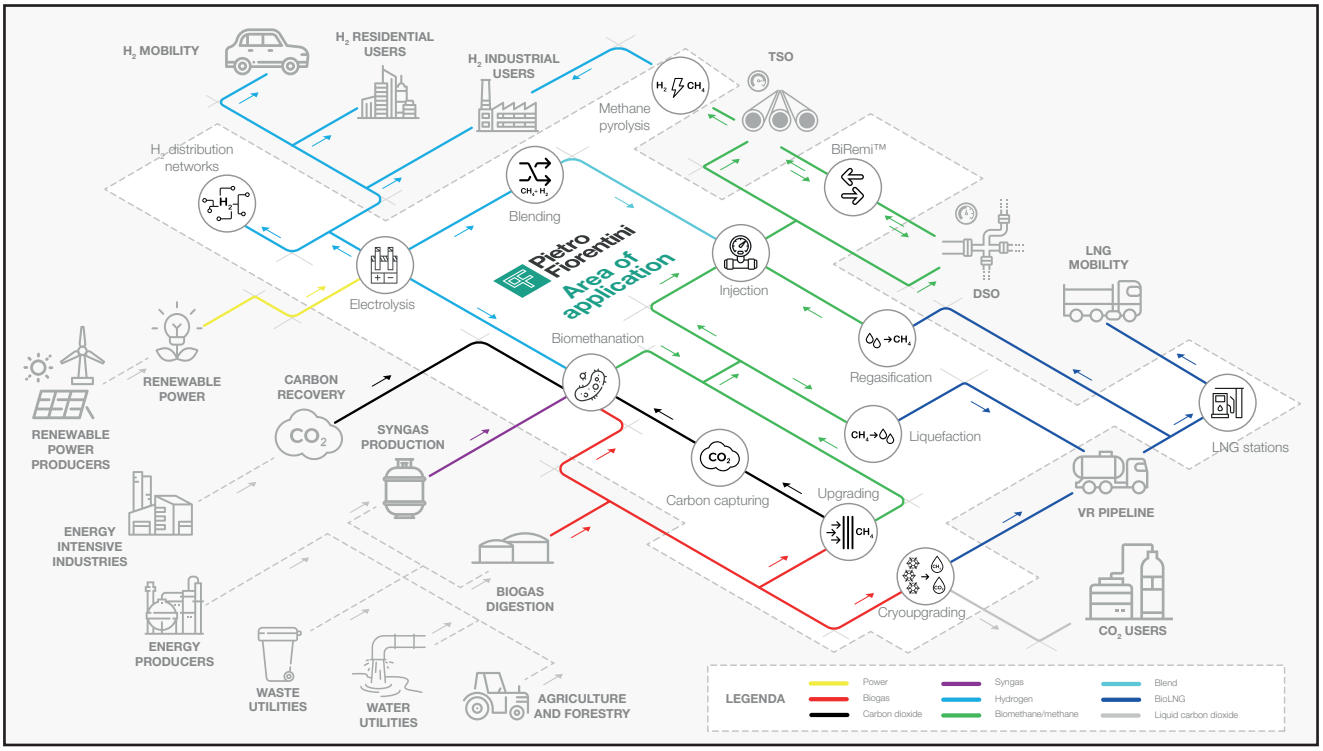
PIETRO FIORENTINI GROUP

Founded in:
1940

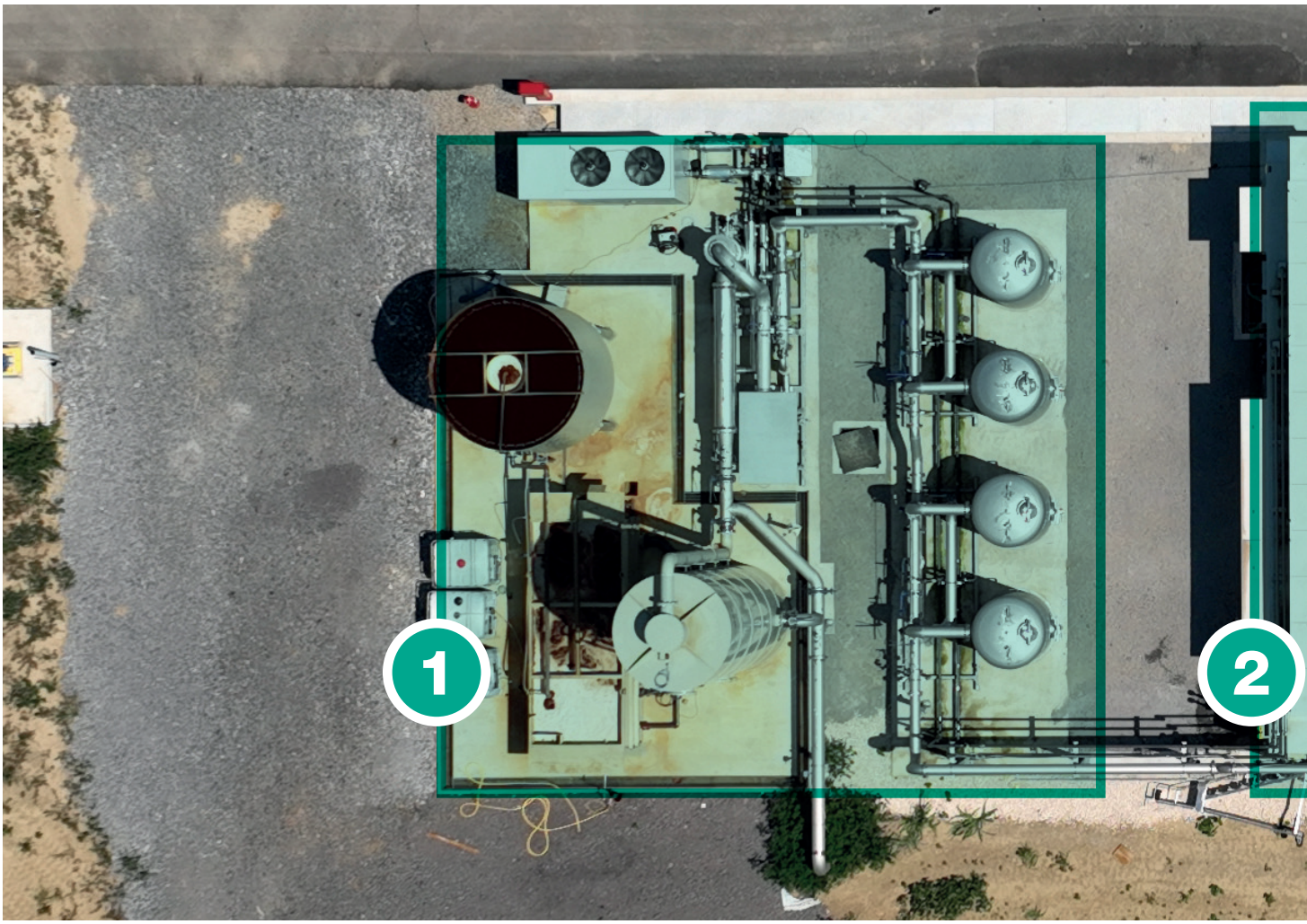
Headquarter:
Arcugnano (VI)

Pietro Fiorentini Group wants to lead the new future scenarios as protagonist: **digitalization, transition towards cleaner energy sources** and great responsibility on economic, social and environmental sustainability.

PIETRO FIORENTINI RENEWABLES PORTFOLIO



HOW THE **UPGRADING** AND **INJECTION**



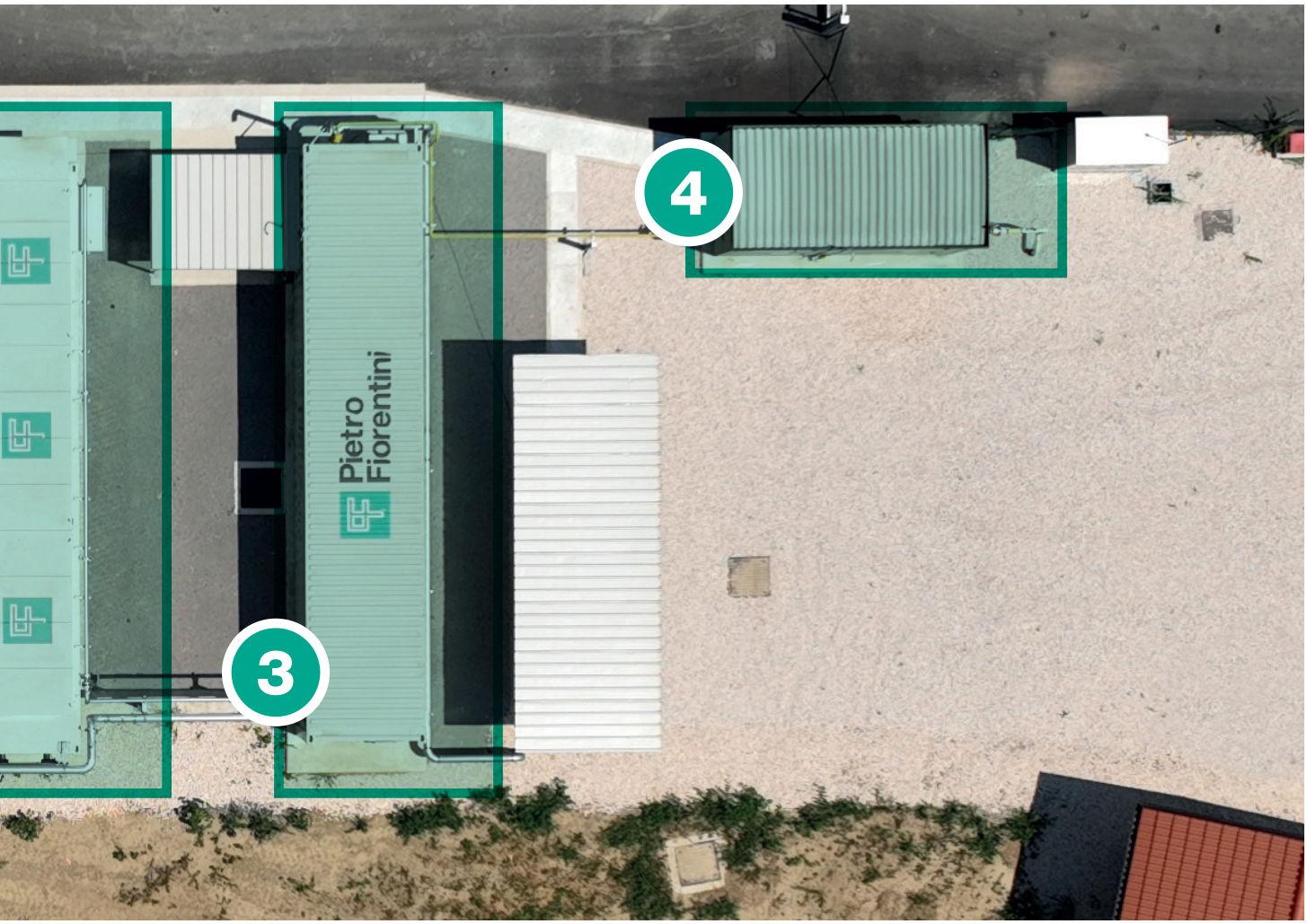
1 PRETREATMENT & PREFILTERING

- **Desulphurization & dehydration**: **H_2S content** in the biogas **is reduced** from thousands to around 100 ppm thanks to a specific washing treatment. After this, **water is removed** from biogas in a **dehydration section**.
- **Activated carbon filtering**: the **residual H_2S** content **is removed** together with **Volatile Organic Compounds (VOCs)**.

2 COMPRESSION

The purified and dehydrated biogas enters the **compression** system to reach an operating pressure ranging from **10** to **18 barg**. From this section, **heat is recovered** for usage into other processes (e.g. for warming up anaerobic digestors).

I SYSTEM WORKS



3 UPGRADING

FIOGrade+ membrane system separates carbon dioxide from clean biogas in order to obtain pure biomethane with high CH_4 content and **compliant for injection into the grid** infrastructure. From this system **CO_2 can be recovered** and purified for its valorization as green biogenic CO_2.

4 GRID INJECTION

FIOGrid↘ injection system accurately analyses biomethane, ensuring that its composition **complies with the required quality standard** prior to injection in the gas grid. FIOGrid↘ solution comprises **pressure regulation, measurement, quality assessment** and eventual **odorization**.

PRETREATMENT & PREFILTERING

Pretreatment and prefiltering are essential steps in biomethane upgrading plants, as they ensure that raw biogas is adequately cleaned and prepared for CO_2 separation. By effectively removing impurities such as hydrogen sulfide, moisture, siloxanes, particulates and VOC, these steps allow the protection of upgrading equipment, to enhance operational efficiency, and to ensure the production of high-quality biomethane. Well-designed pretreatment and prefiltering systems are crucial for an efficient and durable biomethane production process.
The solution includes desulphurization, dehydratation and activated carbon systems.

Equipment protection

Pre-treatments prevent corrosion, fouling and damage to upgrading equipment, ensuring longer lifespan and lower maintenance costs.

Safety improvement

Toxic and hazardous components like H_2S and ammonia are removed, enhancing plant operations safety.

Compliance with standards

All contaminants are lowered to a level compliant with quality standard, even with varying biogas composition.

BIOGAS COMPRESSION

Biogas compression facilitates the conversion of raw biogas into high-purity biomethane suitable for various applications. By increasing gas pressure, biogas compression enhances energy density, optimizes upgrading performance, and enables efficient storage and transportation.

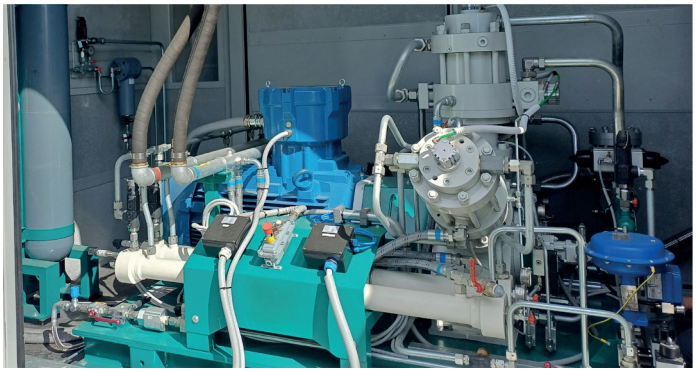
Optimized upgrading performance

- Properly compressed biogas ensures optimal performances in biogas upgrading process allowing for maximum biomethane yield and quality.
- It allows consistent and reliable operation, reducing operation downtime and system maintenance costs.

Flexible solutions

- **Screw compressors** for optimized efficiency within biogas membrane upgrading and subsequent injection in distribution grids, reaching pressure up to 18 barg.
- **Piston compressors** for reaching pressure up to 80 barg, suitable for injection into transport pipelines or for integration in reverse flow systems (BiRemi™).



MEMBRANE UPGRADING

Fiograde+

FIOGrade+ system allows the selective separation of CO_2 from biogas and high-purity biomethane production, suitable for injection into gas grids or as vehicle fuel.

Electric consumption	< 0.29 kWh/Nm^3 raw biogas
Methane recovery	> 99.5%
Methane purity	up to 98%
Biomethane output pressure	from 10 to 18 barg

Advantages of membranes

- High selectivity to CO_2 and high separation efficiency.
- Flexibility in the design of individual stages thanks to different membrane types and sizes, suitable for a modular approach.
- Resistance to vibration and corrosion.
- Reliability: membranes are a “passive” technology with no moving parts and simple control philosophy.
- Compact design with easy installation and maintenance.

FIOGrade+

Thanks to the FIOGrade+ upgrading technology, CO_2 and biomethane contained in pretreated biogas are separated with an overall efficiency around 99.5%. Thanks the compact and flexible configuration, FIOGrade+ is an optimal and scalable solution, suitable for a wide range of biogas flows and compositions.

BIOMETHANE INJECTION SYSTEM

Fiogrid

Biomethane injection plays a crucial role in the integration of purified biomethane into the existing natural gas infrastructure. Injection allows biomethane to be seamlessly distributed alongside conventional natural gas networks to end-users, such as residential, commercial, and industrial consumers.

Injection skids

These compact skids are fully integrated with upstream plant units, allowing for a unique and simple control of the whole system.

Smart metering systems

Advanced analytics and smart metering enable real-time monitoring and control of key operational parameters, such as pressure, flow rate and composition.

FIOGrid

With injection into the natural gas grid, biomethane is sent directly to final consumers. For this reason, FIOGrid solution includes several crucial steps: quality analysis, metering, compression, pressure regulation and odorisation.

CRYOGENIC TECHNOLOGIES FOR LIQUEFACTION

Cryo Inox, part of Pietro Fiorentini Group since 2022, is specialized in advanced cryogenic technologies and has 20+ years of experience in biomethane and CO_2 liquefaction. Committed to sustainability, it provides, through ADD Synergy brand, eco-friendly energy solutions for biogas and biomethane, encompassing small-scale liquefaction, distillation, regasification, storage and truck loading plants. Moreover, it provides solutions for CO_2 liquefaction and direct biogas treatment through a compact integrated process called cryo-upgrading, meant to simultaneously produce bio-LNG and liquid CO_2 from raw biogas.

Biomethane liquefaction & biogas cryo-upgrading

Biomethane liquefaction is adapted for perfect integration with biogas upgrading, being the perfect solution when high-quality bio-LNG is needed downstream biogas upgrading. When also CO_2 can be valorized, it's possible to directly and simultaneously transform biogas into bio-LNG and liquid food-grade CO_2 thanks to a flexible, integrated and turn-key solution called cryo-upgrading. These plants are always integrated with complete metrology, storage and truck loading systems for both bio-LNG and liquid CO_2.

Pietro Fiorentini supplies comprehensive solutions for biogas, biomethane & CO_2 treatment and liquefaction, thanks to advanced cryogenic technologies developed by Cryo Inox (ADD Synergy brand). Whether bio-LNG is required with or without liquid CO_2 (up to food-grade quality), Pietro Fiorentini offers a specific, optimized and custom-made solution.

CO_2 capture, treatment and liquefaction

When an existing or new biomethane plant is willing to capture and valorize CO_2 from biogas, Pietro Fiorentini offers ad-hoc solutions that integrate with different types of biogas upgrading technologies. The proposed solutions comprise off-gas captation, thorough treatment for reaching high CO_2 purity and liquefaction.
The system also includes storage, in which CO_2 is kept under liquid state, together with dedicated metrology and cryogenic pump to load trucks for product transportation to final users.

This system allows for the production of extremely high-purity liquid CO_2, up to food-grade quality (CO_2 > 99.99%) for usage in the food and beverages sector.

BIREMI™ REVERSE FLOW SYSTEMS

BiRemi™

The increasing delocalized production of renewable methane is changing the paradigm of mono-directional gas grid systems. The points of production of renewable methane are often far away from big high-pressure pipelines (transport grid) and can only have access to local low-pressure small infrastructure (distribution grid), which are almost always characterized by limited capacity. To inject renewable methane into the grid without capacity issues, reverse-flow unit are needed. Pietro Fiorentini's BiRemi™ works as a bi-directional system and is able to shift the gas from transport to distribution grid, and viceversa, while ensuring quality assessment, fiscal measurement, compression/pressure regulation and odorization/de-odorization.

BiRemi™ enables delocalized DSO to free capacity and absorb new biomethane production.

Fiograde+ Fiogrid↘ → DSO ⇆ BiRemi™ ⇆ TSO

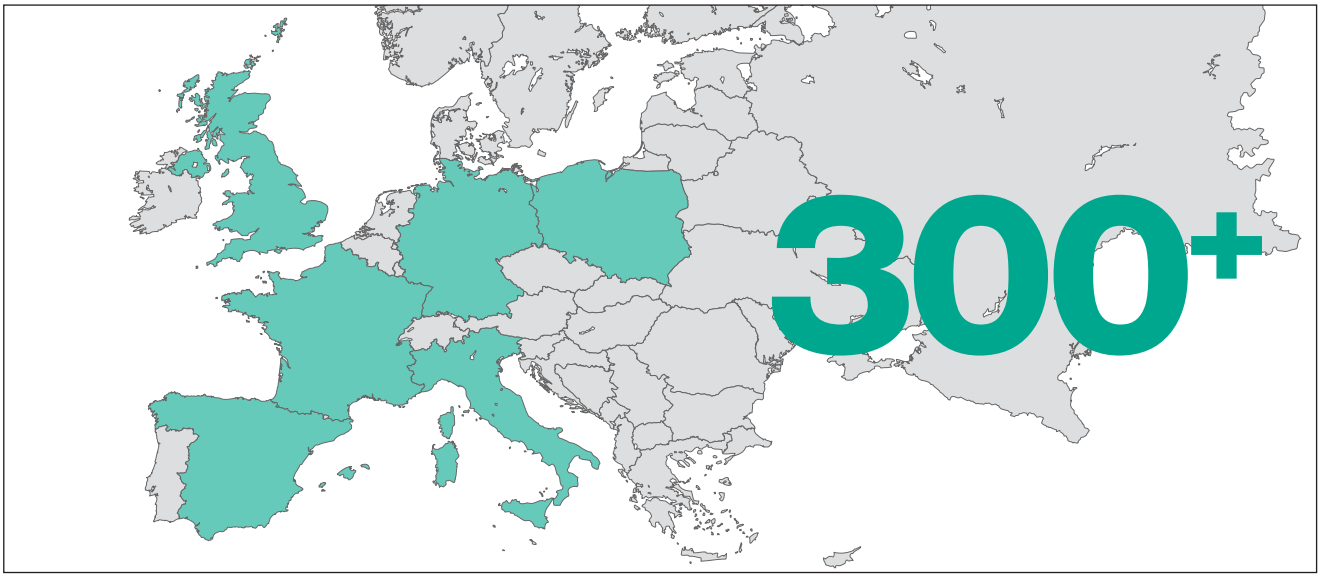
First 5 Italian plants made by Pietro Fiorentini

Engineered, manufactured and supplied within the experimental campaign promoted by ARERA for projects aimed at optimizing gas infrastructures.

5 BiRemi has been provided to different distribution grid operators: **2i Rete Gas, AS Retigas, LDRETI, Centria** and **Ireti Gas**.

REFERENCES

300+ solutions in EU



SELECTED REFERENCES

Bio Sole | Lazzari-Lucchini

From **livestock manure** to **biomethane**

Location	Montichiari (Italy)	
Customer	Lazzari / Lucchini	
Solution	Upgrading + grid injection	
Input / diet	Livestock manure	
Output / final product	Biomethane injected into the grid	
Effective capacity	Biomethane	330 Nm^3/h

Ely | Pretoria Energy UK

Maximum **biogas valorization** and minimum carbon footprint

Location	Ely, United Kingdom	
Customer	Pretoria Energy UK	
Solution	Biogas upgrading + bio LNG +liquid CO_2	
Output / final product	Bio LNG + liquid food-grade CO_2	
Effective capacity	Bio LNG	50 TPD (3.000 Nm^3/h)
	Liquid CO_2	100 TPD

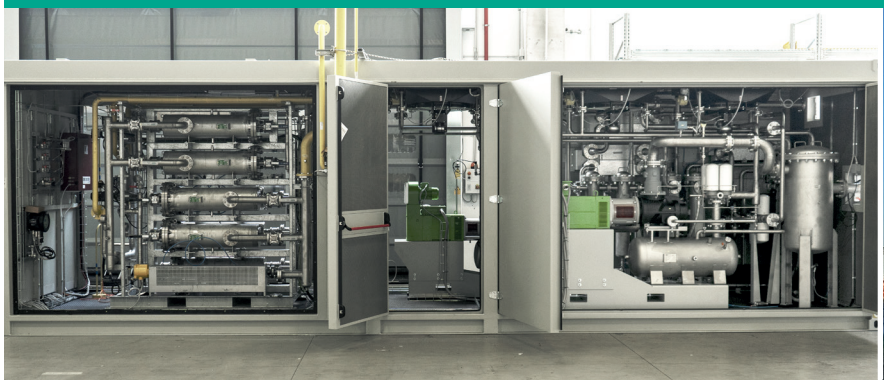
Finale Emilia | AS Retigas

Towards **the flexibility** of **gas infrastructure**

Location	Finale Emilia (Italy)
Customer	AS Retigas
Solution	BiRemi™
Output / final product	Biomethane compressed and injected from DSO to TSO
Effective capacity	500 Nm^3/h biomethane

Piacenza | Bioenerys-Emiliana Agroenergia

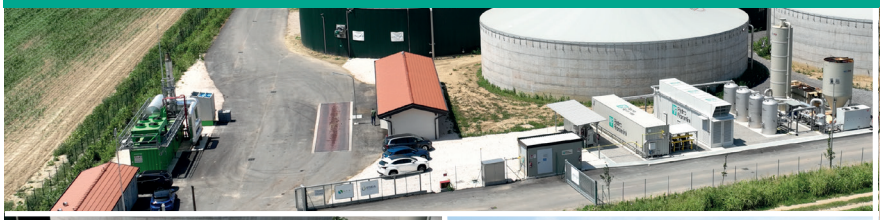
From **agri-waste** and **livestock manure** to **biomethane**



Location	Piacenza (Italy)	
Customer	Bioenerys / Emiliana Agroenergia	
Solution	Biogas upgrading	
Input / diet	Livestock manure	
Output / final product	Biomethane injected into the grid	
Effective capacity	Biomethane	400 Nm^3/h

Cella Dati | EGEA-Santini Agricoltura Rinnovabile

From **livestock manure** to **biomethane**



Location	Cella Dati (Italy)	
Customer	EGEA / Santini Agricoltura Rinnovabile	
Solution	Upgrading + Injection + BiRemi™	
Input / diet	Livestock manure	
Output / final product	Biomethane injected into the grid	
Effective capacity	Biomethane	600 Nm^3/h

Le Cortine | Siena Ambiente

From **organic waste** to **biomethane** and **food-grade CO_2**




Location	Asciano (Italy)	
Customer	Siena Ambiente	
Solution	Upgrading + grid injection + CO_2 liquefaction	
Input / diet	Organic Municipal Solid Waste (OMSW)	
Output / final product	Biomethane and food-grade CO_2	
Effective capacity	Biomethane	330 Nm^3/h
	Food-grade CO_2	11 TPD

La Coruña | SOLOGAS

From **organic waste** to **liquid biomethane** and **liquid food-grade CO_2**



Location	La Coruña (Spain)	
Customer	SOLOGAS	
Solution	Cryo-upgrading	
Input / diet	Organic Municipal Solid Waste (OMSW)	
Output / final product	BioLNG + liquid food-grade CO_2	
Effective capacity	BioLNG	6 TPD
	Liquid food-grade CO_2	9 TPD

CUSTOMER SUPPORT AND SERVICES

FIOEYE

Your plant under control

FIOEYE, the app to monitor Pietro Fiorentini Group's biomethane and hydrogen production plants.

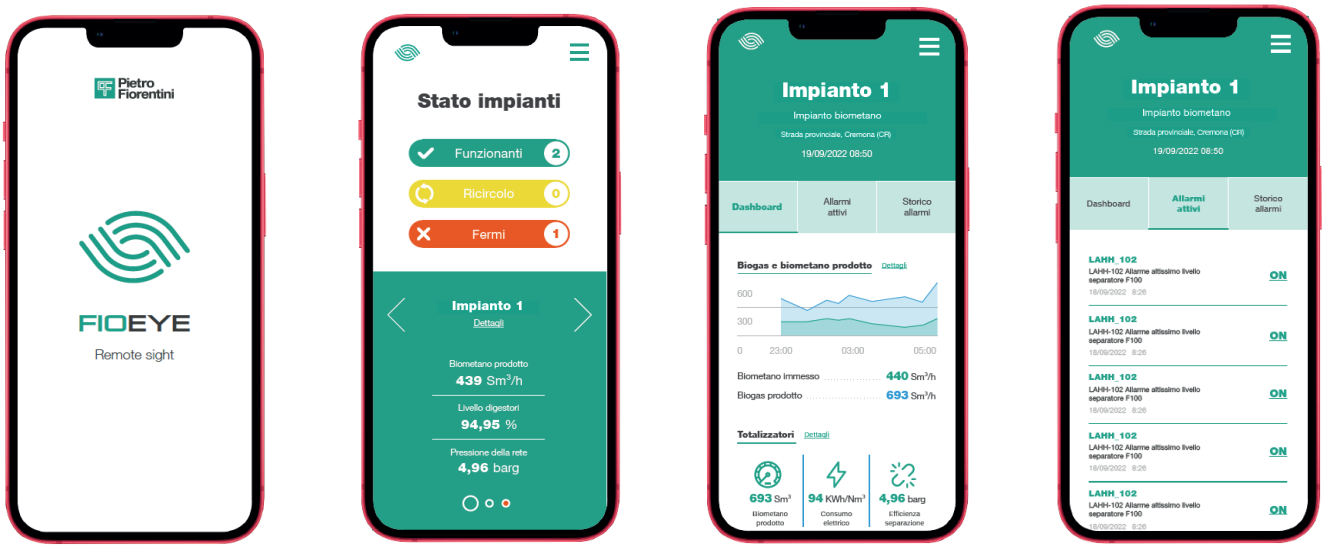
The FIOEYE app allows to remotely monitor the progress of plants producing green molecules, such as biomethane and hydrogen.

For each plant it is possible to:

- monitor key process parameters;
- receive notifications;
- Start&Stop (only for hydrogen plants).

The app makes it easy to estimate the quantities produced, calculate specific electricity consumption and receive notifications in case of problems and plant shutdowns.

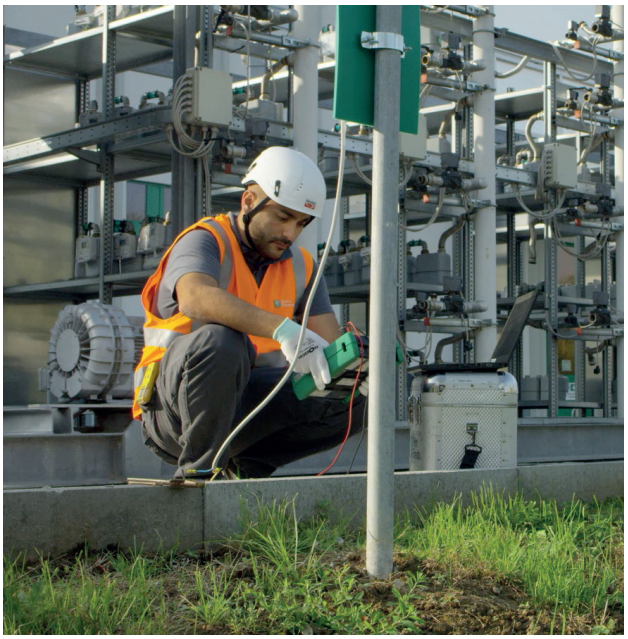
Available for iOS and Android.



SERVICE

Remote service

Service is a fundamental point in our solutions. We handle inspections, metrological controls and maintenance work, up to complete plant management. We measure operating parameters directly and continuously. We can **manage remote automation and promptly notify any anomaly.** Thanks to a capillary presence all over the world, we reduce intervention times and manage emergencies in the best way possible.



On site service

We follow all the process phases of each plant to guarantee continuity, efficiency, quality and low cost management of all interventions, requested and planned. We manage the **scheduled maintenance and functional tests for all our plants**, from the mechanical revision of the process lines to the exchange of systems' components and spare parts.

STRUCTURED AND LOCAL SERVICE

Always at the service of customers

A single point of contact between client and supplier for every component and plant unit. A **unique, comprehensive,** and **worry-free service** approach. This is crucial to reduce downtime and maximize biomethane productivity.

A Group based in Italy but with a local presence in several countries. This guarantees maximum control over plant maintenance and ensures rapid and prompt intervention whenever necessary.

An end-to-end service solution, customized for every single need, offering **flexible contract durations** and multiple service levels:

1	2	3
Basic	**Advanced**	**Full**
Autonomous management with specialized technical support	A balance between autonomy and support	The worry-free option for those who wish to fully delegate plant management

Pietro Fiorentini

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