



Solutions for renewable energies



**Pietro
Fiorentini**

A young woman with dark hair, wearing a bright yellow jacket and a backpack, is smiling broadly with her arms raised in a lush bamboo forest. The bamboo stalks are tall and thin, reaching towards a bright sky. The overall atmosphere is one of joy and connection with nature.

A clean energy world



**We are committed to innovative projects
that contribute to a more sustainable
future for the new generations.**



Innovative **technologies**

We work on **integrated solutions along the entire natural gas supply chain**: from plants for processing raw biogas and feeding biomethane into the grid, to systems and components that allow networks to utilize hydrogen. We also manage monitoring and remote control systems meant to analyze plants' data flow, maximizing security, enhancing reliability and guaranteeing effective service to the final client.



Pietro Fiorentini Group

Founded in
Bologna in 1940

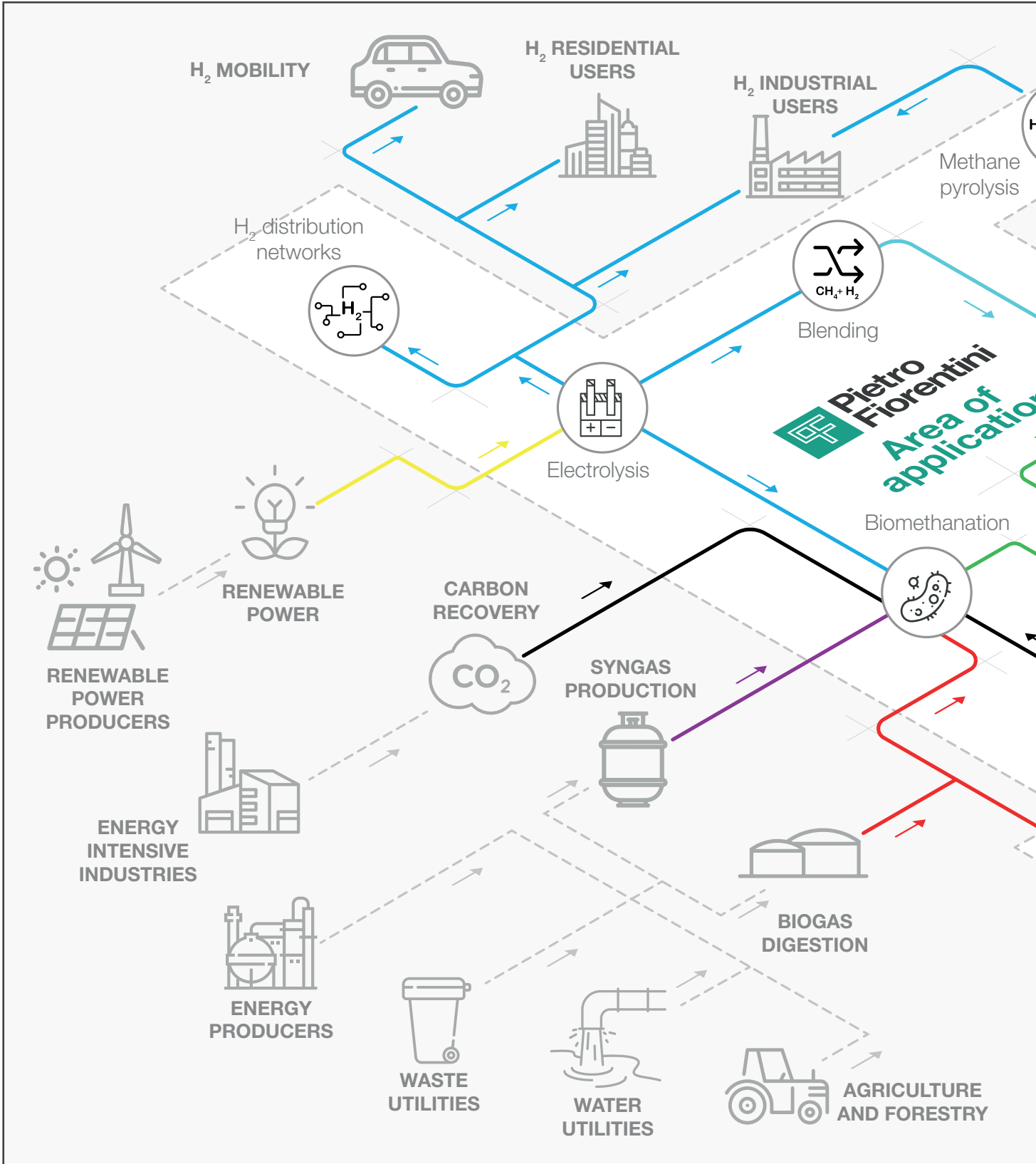
Headquarter:
Arcugnano (VI)



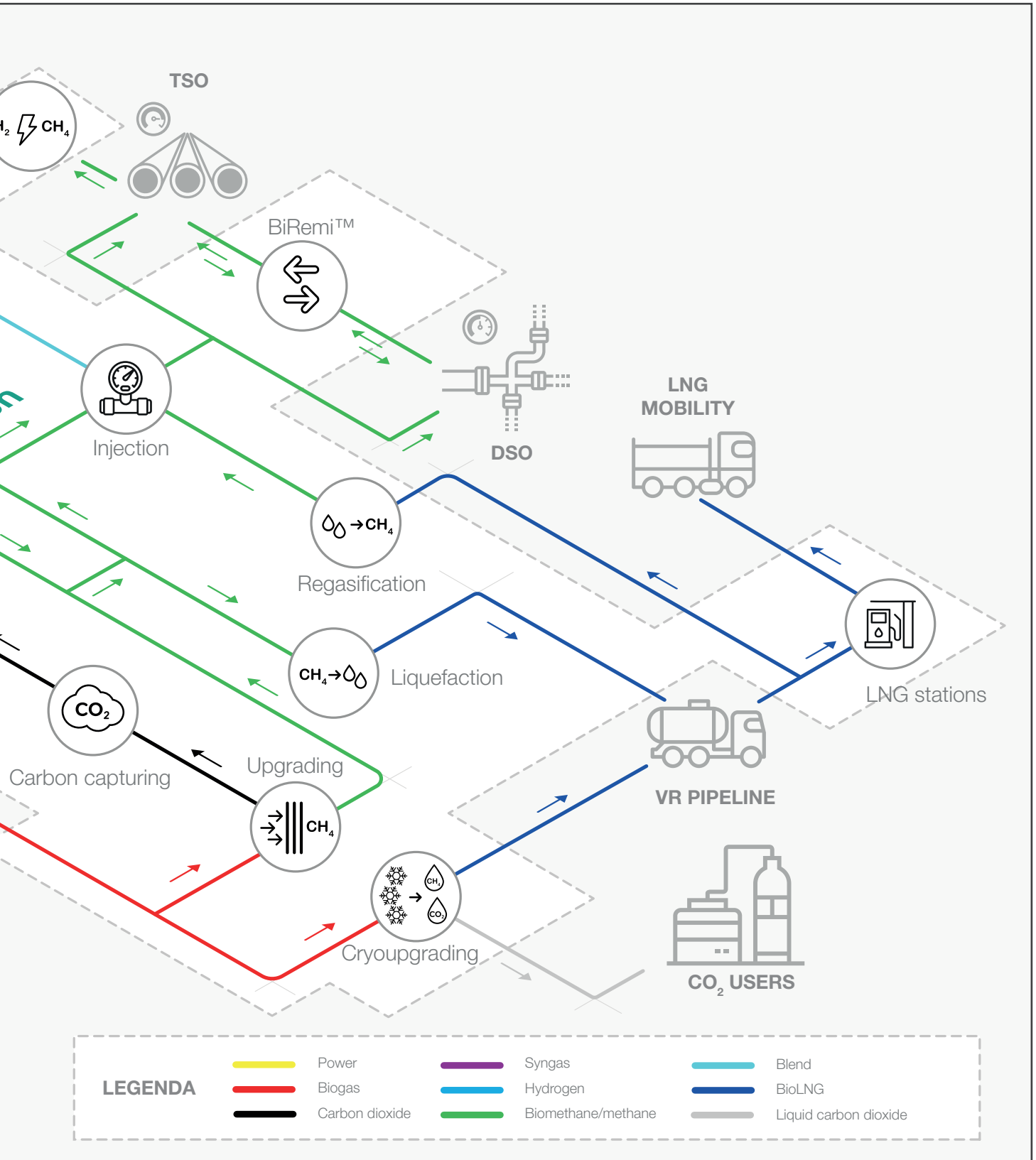
Pietro Fiorentini Group wants to lead the new future scenarios as protagonist: **digitalization, transition towards cleaner energy sources** and greater responsibility on issues of economic, social and environmental sustainability.

Renewables portfolio of Piero

An ecosystem of technologies



tro Fiorentini Group



1st generation

Biomethane from biogas

Biogas is a naturally generated gaseous fuel, coming from controlled anaerobic fermentation (without oxygen) of organic wet biomass, such as agricultural/farm sub-products, urban organic waste or civil/industrial wastewaters and sludges. Biogas contains mainly methane and carbon dioxide, together with water and other contaminants in traces.

With proper treatment and purification, biogas can be transformed into **biomethane**, a sustainable substitute of natural gas, that can be injected into the existing gas grid or utilized as bio-CNG/bio-LNG.

Our complete and integrated biogas **upgrading solution - FioGrade** allows to efficiently remove water and contaminants (like sulphur, ammonia and organic compounds), while separating out carbon dioxide thanks to membranes filtration. The entire process allows to recover around 99,5% of the methane contained in input biogas, producing a pure stream that can be directly injected into the gas grid. As presented here, the upgrading is integrated with our **grid injection solution - FioGrid**, comprehensive of quality assessment, measurement, compression/pressure regulation and odorization.

Valorizing “wet” by-products

Agricultural



Water treatment



Organic wastes



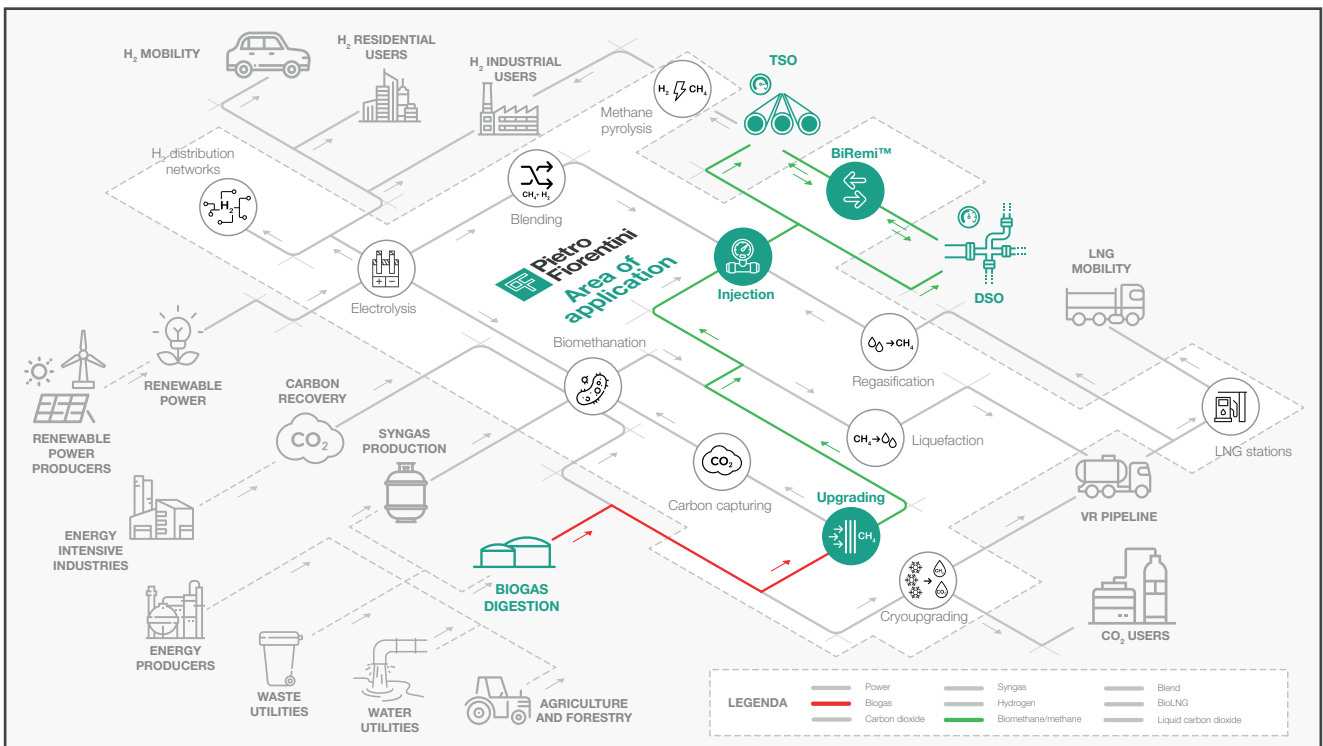
Intermediate harvests



Integrated biogas upgrading & biomethane grid injection



Area of application



2nd generation

Renewable methane from syngas

Synthesis gas, or **syngas**, is generated by gasification of solid biomass, like wood, ligno-cellulosic agricultural residues or plastic-based wastes. Syngas consists of a mixture of carbon monoxide and hydrogen, with smaller amounts of carbon dioxide and methane. Depending on gasification process and input biomass, syngas usually also contains a variable quantity of pollutants, like tars, sulphur and other complex organic compounds. These latter pose significant problems and challenges related to syngas conversion systems, which are mostly relying on catalytic processes that require very high purity of inlet streams.

Our **biological methanation solution** allows to convert syngas with minimum pre-treatments into renewable methane, thanks to controlled biological reactions of hydrogen with carbon monoxide and carbon dioxide. The technology for this process is developed by **MicroPyros BioEnerTec GmbH™**, part of Pietro Fiorentini Group.

The produced renewable methane can then be injected into the grid or utilized as bio-CNG/bio-LNG, just like biomethane.

Valorizing “solid” by-products

Forestry / wood waste



Waste sludges



Solid recovered fuels



Agricultural residues



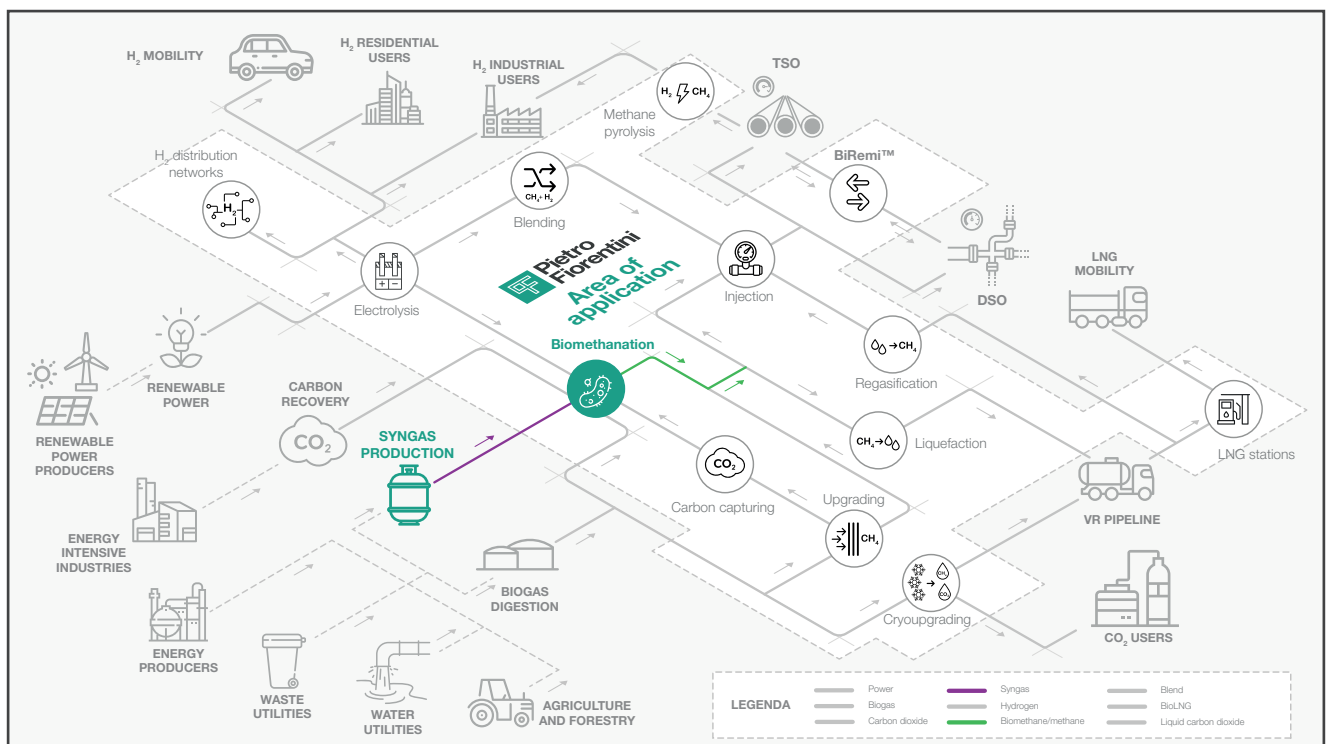
MICROPYROS

MicroPyros BioEnerTec GmbH™, a biotechnological company with headquarter in Straubing, Germany, is one of only few knowledge centres in the world able to apply **biological methanation** to industrial gas processes. Since 2021 it is part of Pietro Fiorentini Group, but it has more than 40 years of experience in the biological development and optimization of **Archaea**, the microorganisms adopted to convert hydrogen and carbon oxides into **renewable methane**.



Thanks to its long past experience, MicroPyros now owns 70 customized strains of Archaea, which can be applied alone or in different combinations, in order to adapt to numerous variable conditions and input gas compositions. Biological methanation can be applied to either transform syngas into **renewable methane (2nd generation)** or in Power-to-Gas applications, where green hydrogen and CO₂ are converted into **e-methane (3rd generation)**.

Area of application



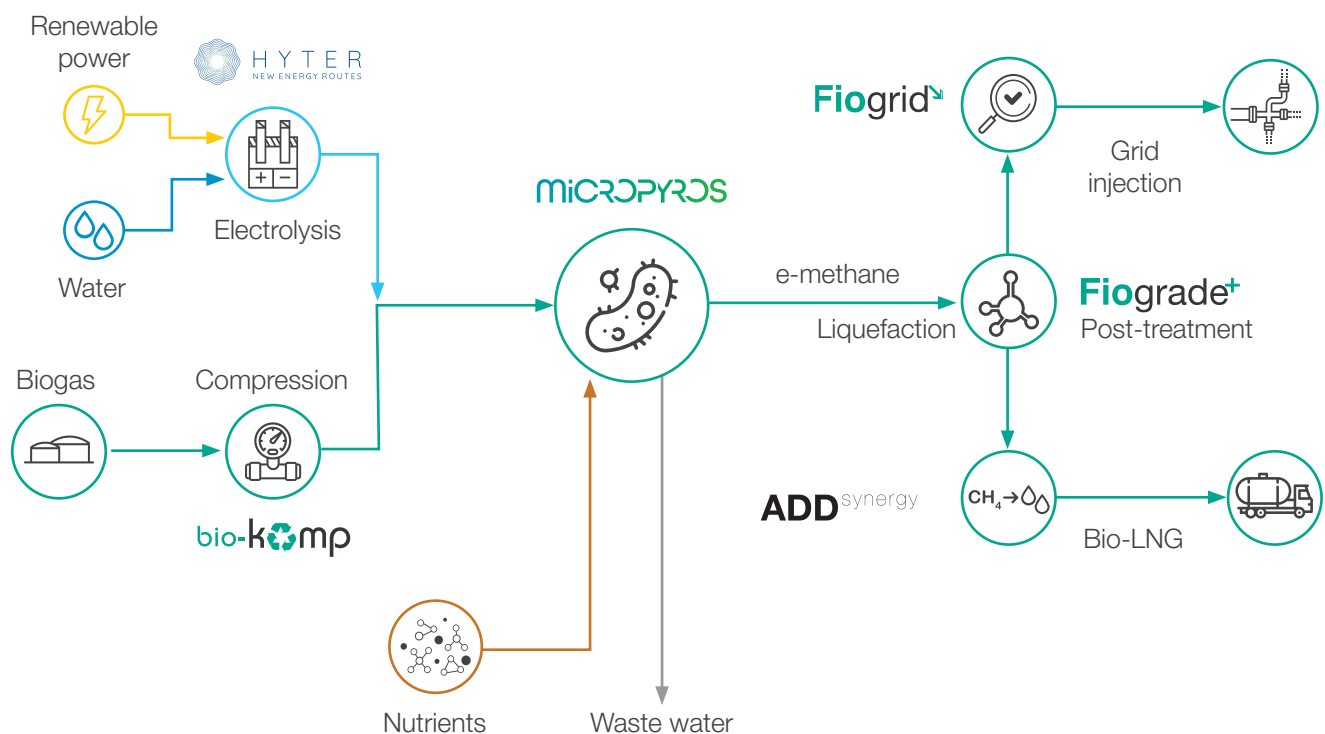
3rd generation

E-methane from electricity and CO₂

Renewable electricity generation, mainly coming from solar and wind energy, is characterized by high variability and low predictability. The rapid expansion of renewable power generation is posing issues in balancing electricity demand and offer, causing over the years the generation of increasing amounts of energy that cannot be utilized and consequently end up wasted.

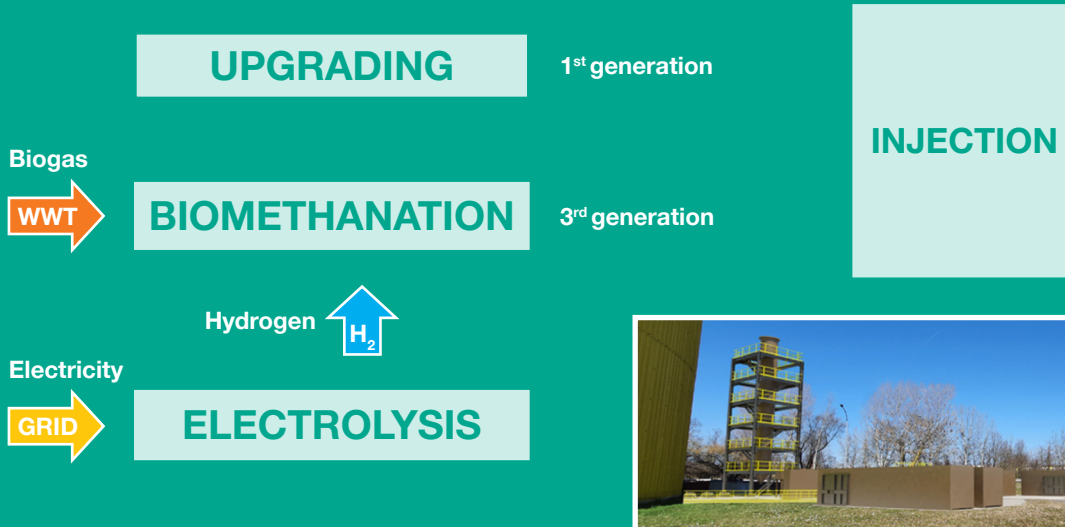
From here, there is the pressing need to transform excess electricity into an easy-to-handle, storable and transportable form. Power-to-Gas, and especially Power-to-Methane, offers a valuable and promising option to valorize renewable electricity surplus under the form of methane, better known as electric methane (or **e-methane**), derived from electricity.

Our **Power-to-Methane** solutions work by first absorbing electric power to produce renewable hydrogen, thanks to **Hyter** electrolysis technologies. Hydrogen is then mixed with captured CO₂ (coming from biogas or other sources like flue gases) and fed to a biomethanation unit, that enables to produce e-methane thanks to specific biological catalysts, Archaea, developed by **MicroPyros**.

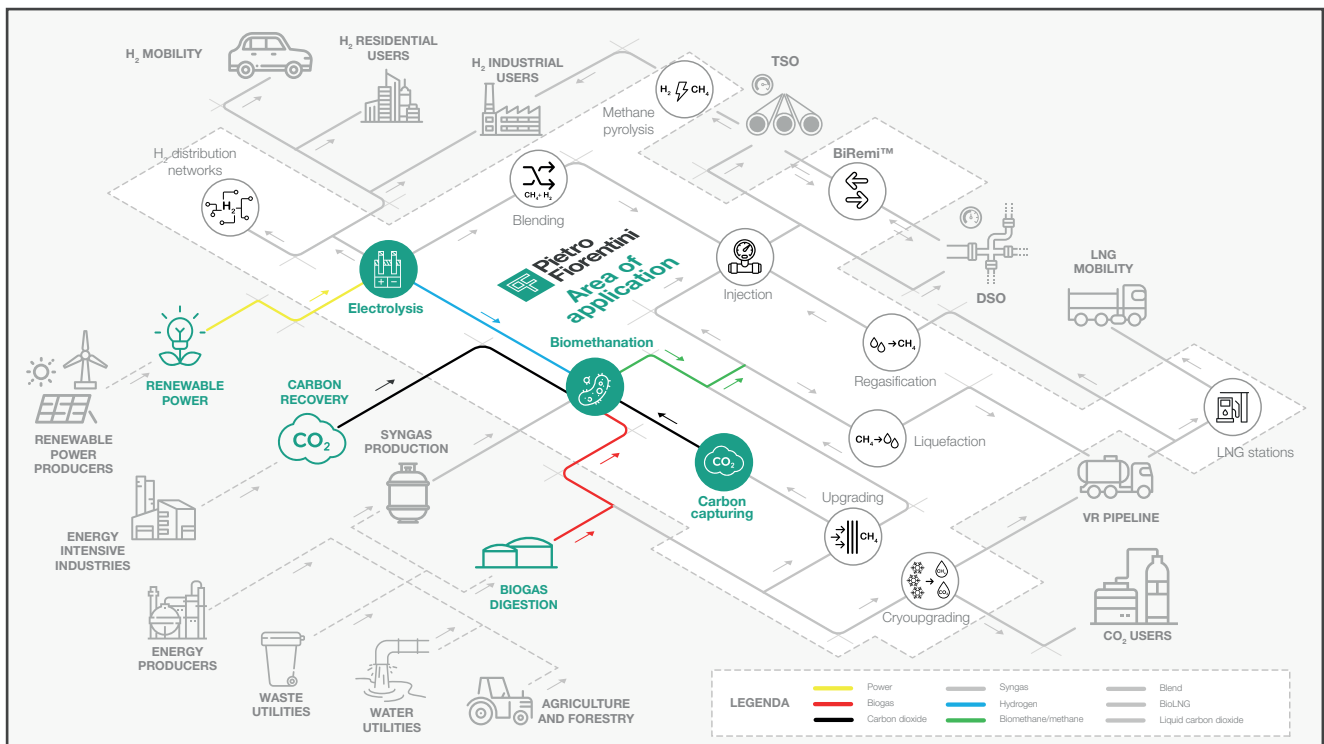


SynBioS (2022)

SynBioS, located in Bologna Corticella, is inside the largest purification plant managed by the HERA Group. The plant, which uses “power-to-gas” technology to convert renewable electricity into synthetic natural gas, not only increases the pollutant reduction potential of the sewage treatment plant, but also allows excess renewable energy to be valorised by reusing biomethane in the city’s distribution network, which thus acts as a long-term storage facility.



Area of application

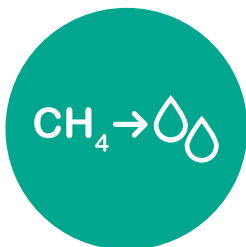


Bio-LNG

ADD synergy

When the grid is not available and **biomethane** has to be efficiently transported or used as transport fuel in heavy-duty vehicles, it **can be converted into liquid** form and become **bio-LNG**. Biomethane liquefaction, indeed, allows for **efficient storage**, transportation, and distribution of this valuable resource through the so-called virtual pipeline, as an alternative mode to the traditional pipeline network.

ADD Synergy, based near Barcelona and part of Pietro Fiorentini Group since 2022, is an industrial and technological company with 20+ years of **experience in methane and CO₂ liquefaction**. Specialized in **advanced cryogenic technologies**, it is committed to sustainability and provides eco-friendly energy solutions for natural gas, biogas and biomethane, encompassing small-scale liquefaction, distillation, regasification, storage and truck loading plants. Moreover, ADD Synergy provides solutions for **CO₂ liquefaction** and direct biogas treatment through the **Cryogenic Upgrading** (Cryo-Upgrading), meant to simultaneously produce bioLNG and liquid CO₂ from raw biogas.



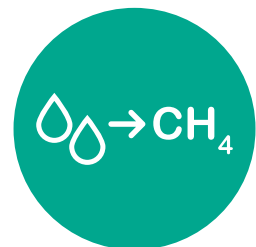
Methane
and CO₂
liquefaction
plants



Truck loading
facilities



LNG & CNG
fueling
stations



Regasification
plants

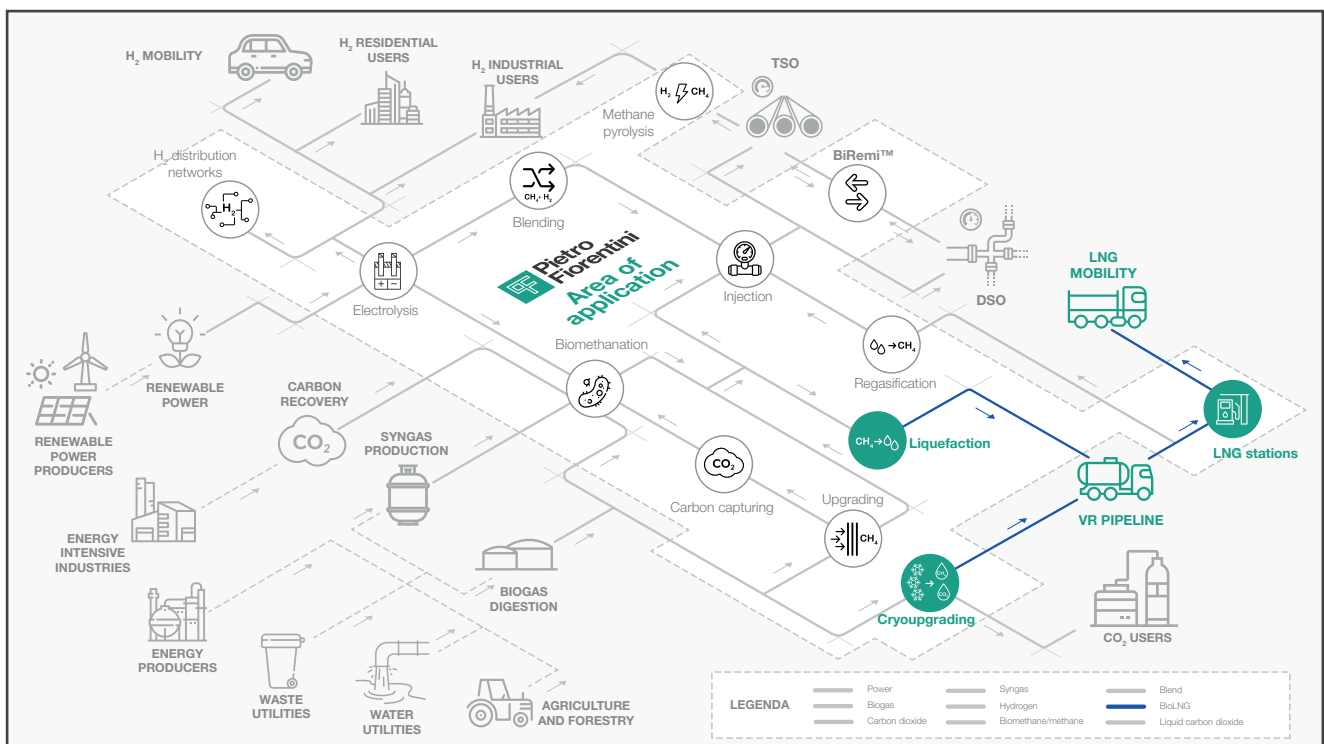


SOLOGAS: cryo-upgrading

A flexible, integrated and turn-key solution that allows to directly transform biogas from organic waste into valuable products such as liquid biomethane and liquid food-grade CO₂. By using a combination of innovative technologies, including Cryo-upgrading, membrane polishing, and rankine mixed refrigerant liquefaction, the plant is able to operate efficiently and competitively even on a small scale. Commissioned at beginning of 2024, the plant will produce 6,1 TPD (Tons Per Day) of LNG and 8,8 TPD of food-grade liquid CO₂.



Area of application



CO₂ capture and utilization

CO₂ capturing is a solution meant to intercept carbon dioxide emissions from various emitting sources (such as industrial processes) and **prevent their release into the atmosphere**. This family of technologies helps mitigate greenhouse gas emissions by avoiding the CO₂ impact on the environment.

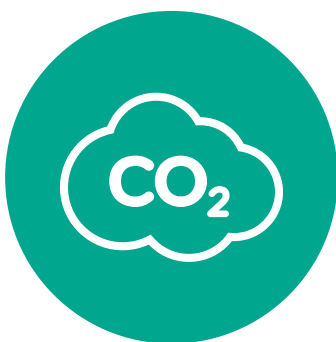
The captured CO₂ can then be **stored, utilized** in various applications (for example food&beverage industry) or converted into valuable products, like e-fuels.

CO₂ capture

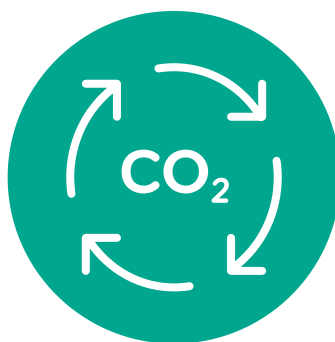
As Pietro Fiorentini we offer specifically designed solutions to capture CO₂, especially from biogas plants, and purify it up to food-grade quality. Thanks to ADD Synergy solutions, the captured CO₂ is liquefied, stored and loaded on cryogenic tanks for its transport to the final user.

CO₂ utilization

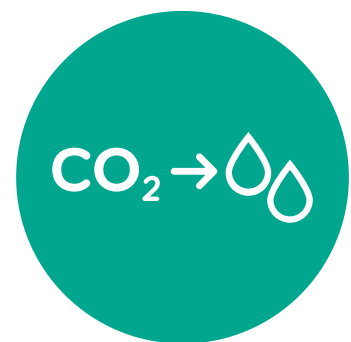
We give our contribution to CO₂ utilization by adopting bio-methanation processes. MicroPyros BioEnerTech, part of Pietro Fiorentini Group, is one of the three companies in the world that has harvested and developed specific microorganisms, called Archaea, for biological methanation. Currently more than 70 different strains of Archaea are stored at -80° C to further develop their selection and cultivation. These microorganisms metabolize hydrogen and carbon dioxide, producing renewable methane as a final valuable product. The process is totally green and just releases water as a byproduct.



Biogas
CO₂
recovery



Exhaust
CO₂
treatments



CO₂
liquefaction



Biogas CO₂ recovery and liquefaction

Pietro Fiorentini has recently implemented a CO₂ liquefaction system in Siena, Italy, **integrated with an upgrading plant**. The main objective of this project is the **capture and transformation** of the off-gas coming from **upgrading into high-quality valuable product**. With the use of advanced technologies such as membrane upgrading and a new distillation process, the plant is able to successfully purify and liquefy CO₂ completely avoiding methane slip from the upgrading process. The final product is liquid food-grade CO₂ that can be used in the food&beverage sector as a green substitute of the fossil CO₂ previously used.



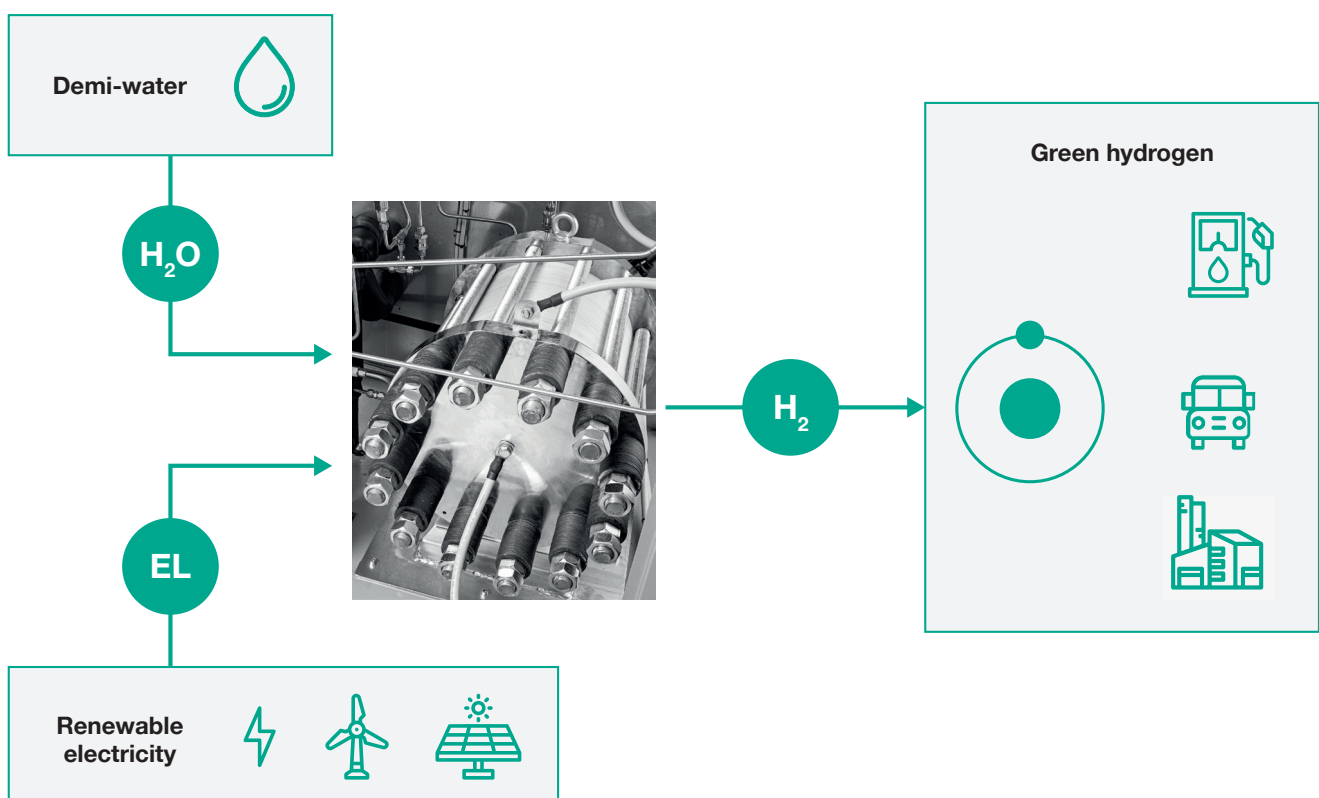
Green hydrogen



Hyter is a company operating in the hydrogen sector since 2011. It joined Pietro Fiorentini Group in July 2021. The company develops solutions to generate **green hydrogen through water electrolysis**, with a wide range of size, from **from kW to multi-MW**. **AEMWE (proprietary)** and **PEM technologies** are the core of Hyter's solutions: while the first one is based on anionic exchange membrane, the second exploits protonic and exchange membrane.

Both technologies allow to satisfy multiple needs within the energy transition process. For example, they enable hydrogen storage, thus stabilizing the variability of the production of electricity from renewable sources, very often not aligned with consumption. There are also several other applications, like sustainable mobility, sector coupling or industrial applications.

Hyter's proprietary AEMWE technology



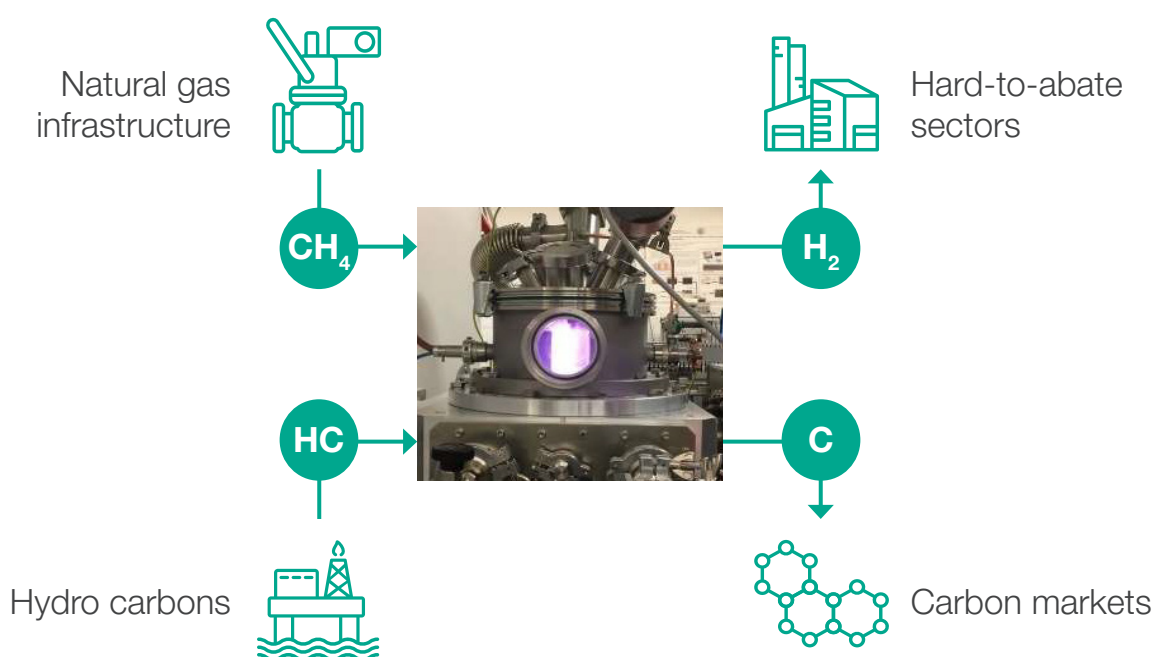
Turquoise hydrogen



Hydrogen is a key pillar to achieve the targets of the global decarbonization strategy, having a fundamental role in decarbonizing the Hard-to-abate industrial sector and in enabling renewables integration into the grid by sector coupling. Still, supplying hydrogen at low cost and in a sustainable way is a huge technological and systemic challenge.

The new technological frontier for this is **turquoise hydrogen**, generated from the pyrolysis (thermal decomposition) of either methane or light hydrocarbons, to produce hydrogen and solid carbon.

X-nano, spin-off of Italian Institute of Technology (IIT) and part of Pietro Fiorentini Group, is constituted by scientists and researchers with deep know-how on **nanomaterials** and **nanocoatings**, generated by plasma, laser and thermally assisted reactions in supersonic and subsonic flow jets. They have developed a special system able to simultaneously produce decarbonized hydrogen (turquoise hydrogen) and nano-structured carbon materials, applicable as electrodes for batteries and electrolytic cells. Besides generating two value streams, this process is significantly less energy-intensive than water electrolysis and can benefit from the existing NG infrastructure.



Grid readiness

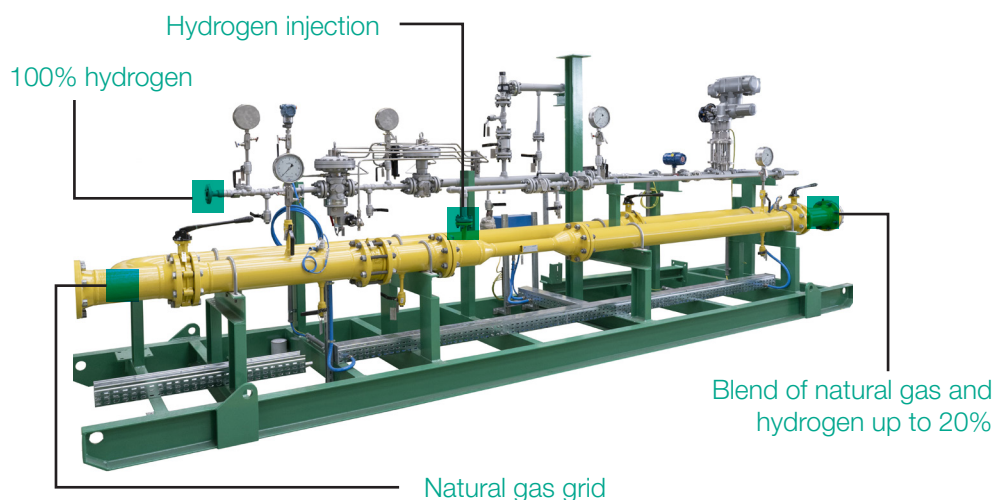
Reverse flow systems – BiRemi™

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 characterized by limited capacity. To inject renewable methane into the grid without capacity issues, reverse-flow systems are needed: they divert gas flow from distribution to transport grid, making the overall system bi-directional.

Pietro Fiorentini's **BiRemi™** works as a bi-directional system able to shift the gas from transport to distribution grid, and viceversa, while ensuring quality assessment, measurement, compression/pressure regulation and odorization/de-odorization.

Hydrogen blending

Hydrogen networks are on the rise, and especially in the first part of their path, they will have to **work together with traditional natural gas transmission and distribution grids**. Depending on various factors, end users may need several degrees of blending - **up to 20% hydrogen**. This means that a reliable, fast-responding system is needed to blend, analyze and control hydrogen flow in the grid.



We provide **tailor-designed stations for hydrogen blending & injection**, featuring a full-scale industrial design that can be easily adapted from low pressure districts up to high pressure transmission networks and industrial applications.

Full hydrogen technologies

Hydrogen has some fundamental features that make it the perfect ally for facing the planet's energy challenge. Due to its versatility, it can be injected into the existing gas grid, with exploitation of the important existing infrastructure assets. Compared to natural gas, however, hydrogen has many different attributes, in particular about its interactions with different materials. Thus, accurate studies and tests are required to fully understand its impacts, while reliable and safe solutions for its handling are needed.



Hydrogen is an element that can currently only be injected into the pipeline network and mixed with natural gas up to certain percentages. Our commitment is to create technologies and devices that allow this mixing percentage to go up to 100%, a pathway that will open incredible opportunities for the future energy system. In this field, Pietro Fiorentini develops key components for up to 100% hydrogen grids, including a wide set of advanced meters and pressure regulators.

Hydrogen Innovation Lab

On October 20th, 2022, the grand opening event of the Hydrogen Innovation Lab was held. This project saw the building of a multifunctional facility where **hydrogen can be produced** by electrolysis where **blending** of **hydrogen** and **natural gas** can be performed, and the **H₂-ready devices can be tested and optimized**.



[Click here](#) or scan the QR code to see our hydrogen laboratory video presentation.





Your plant under control

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

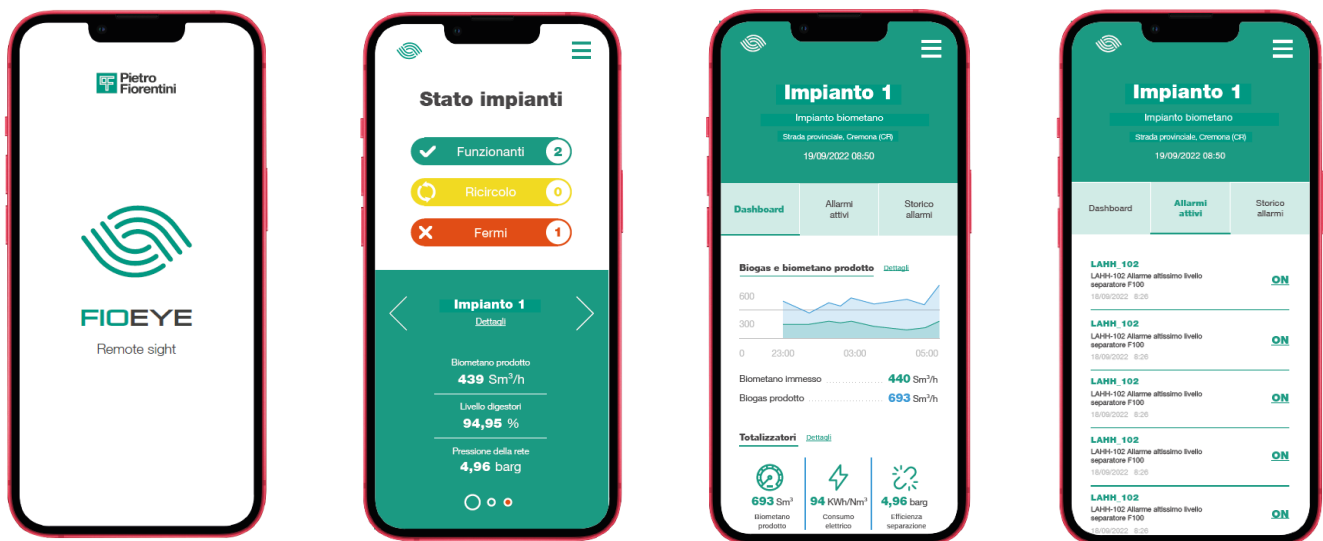
The FIOEYE app allows to remotely monitor the progress of plants producing green molecules, such as biomethane and hydrogen.

For each plant it is possible to:

- Monitor key process parameters;
- Receive notifications;
- Start&Stop, 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 anomalies**. Thanks to a capillary presence all over the world, we reduce intervention times and manage emergencies in the best way possible.



... and on site

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 the gas pressure reduction stations**, for the mechanical revision of the reduction lines, for the release of fumes and the revision of the indirect heaters.

Customer Centricity

Customer centricity is a way of running your business — implementing a perfect customer experience at each stage of the pipeline. Pietro Fiorentini is one of the main Italian international company with high focus on product and service quality.

The main strategy is to create a stable, long-term relationship, putting the customer's needs first. Lean management and customer centricity are used to improve and maintain the highest level of customer experience.



Support

Pietro Fiorentini's top priority is to provide support to the client in all phases of project development, during installation, start up and operation. Pietro Fiorentini has developed a highly standardized Intervention-Management-System (IMS), which helps to facilitate the entire process and putting the customer at the forefront of every decision in our process while manufacturing or developing a product to help improve the product and service. With our IMS business model many services are available remotely, avoiding long waiting times, improving service, and avoiding unnecessary expenses.



Training

Pietro Fiorentini offers training services available for both experienced operators and new customers. The training is offered for all levels of our customers which can include one or all of the following: sizing of equipment, application, installation, operation, maintenance and is prepared according to the level of use and the customer's need.



Customer Relation Management (CRM)

The service and care of our customers are one of the main missions and vision of Pietro Fiorentini. For this reason, Pietro Fiorentini has enhanced the customer relation management system. This enables us to track every opportunity and request from our customers into one single information point and allows us to coordinate information allowing us to give the customer improved service.

Sustainability

Here at Pietro Fiorentini, we believe in a world capable of improvement through technology and solutions that can shape a more sustainable future. That is why respect for people, society and the environment form the cornerstones of our strategy.



Our commitment to the world of tomorrow

While in the past we limited ourselves to providing products, systems and services for the oil & gas sector, today we want to broaden our horizons and create technologies and solutions for a digital and sustainable world. We have a particular focus on renewable energy projects to help make the most of our planet's resources and create a future in which the younger generations can grow and prosper.

The time has come to understand how and why we operate now.





www.fiorentini.com

MICROPYROS

www.micropyros.de



www.hyter.it

X_nano invisible matters

www.x-nano.it

ADD synergy
www.addsynergy.com

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