

Empowering Industry with Decarbonization

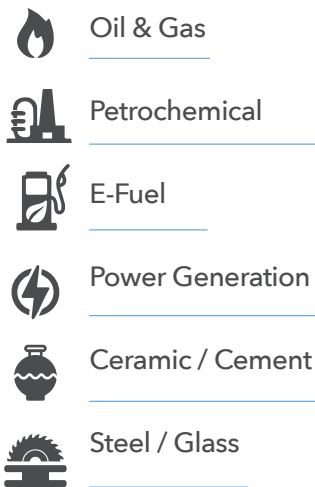
Maximize efficiency. Reduce emissions. Capture returns.

Industry



Overview

Applications



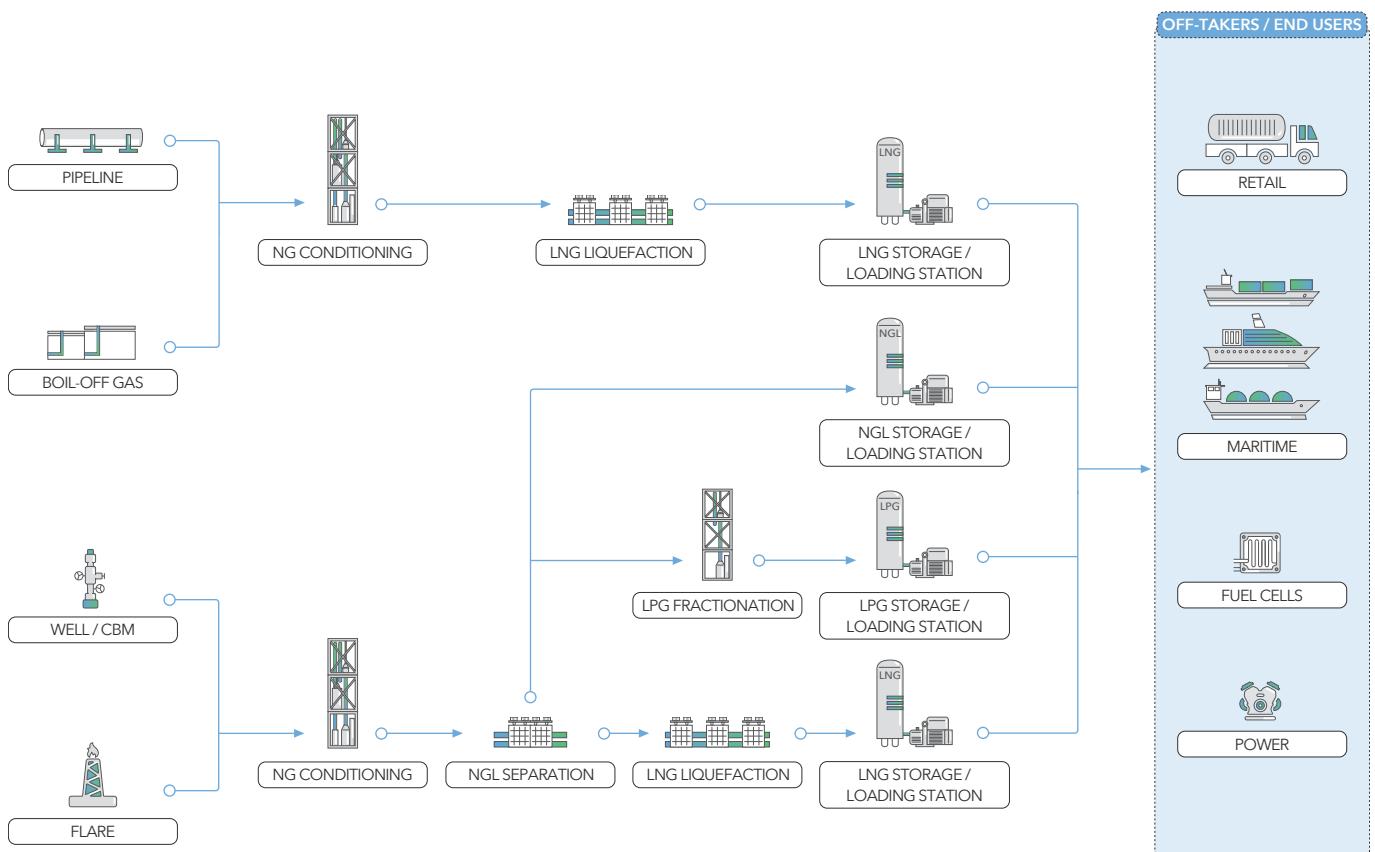
Ecospray provides a variety of **LNG production and liquefaction solutions** to **transform gas streams** - including flare gas, pipeline gas, syngas, and stranded well gas - into profitable NG for transportation, power, and hard-to-abate industries, while also recovering valuable NGLs.

Furthermore, our **carbon capture technologies**, possibly **coupled with CO₂ liquefaction system** (up to 99,9% purity), support the decarbonization of exhaust industrial flue gases, as well as **generate new value by "ready to use or deliver" captured CO₂** (EOR, geological sequestration and SAF).

Our unmanned modular systems are purpose-built for harsh environments and remote operations, offering **superior flexibility in scaling production and adapting to variable inlet gas composition** as well as precise LNG calorific value requirements.

Industry solutions

Ecospray provides a **wide range of solutions for the industry**, leveraging diverse sources to supply different **markets with LNG and captured CO₂**.



Activities

Our 360° approach serves clients along the **entire value chain**:

- › Research & Development
- › Engineering
- › Production
- › Installation supervision & commissioning
- › After sales support
- › Training & management

Service & Training

Ecospray's dedicated **after-sales services** ensure consistent **optimized performances** and plant **reliability** leveraging remote supervision technologies and industry best practices honed from our extensive experience both large marine installations and diverse renewable energy plants.

Our globally recognized **Training Center** provides **tailored courses for professionals**, both in-person as well as online, ensuring operators are properly skilled to maintain systems effectively.

Ecospray training courses help to **maximize efficiency**, to **reduce risks**, and to stay ahead of regulatory requirements.



Natural Gas Liquefaction - LNG

Description

Inlet stream for Dry / Wet Gas:

- Flare / APG
- Pipeline
- Syngas
- Stranded well
- Coal bed methane (CBM)

Ecospray provides **on-site gas liquefaction and separation solutions**, enabling the recovery of waste gases from flare or APG, as well as the creation of a virtual pipelines for the widespread distribution of LNG. This technology eliminates the need to distribute LNG from large storage terminals, significantly reducing logistics costs, risk of unforeseen events, and emissions associated with road transportation.

The liquefaction system is a fully scalable solution built around an in-house designed **cryogenic chiller based on reverse Brayton closed-cycle technology**. The system can be configured to match desired LNG demand characteristics for **bunkering, power generation or transportation**.

Each module has the capacity to produce:

- 9.5 tpd of LNG @ -160°C/-256°F processing 550 Nm³/h or 0.5 MMSCFD;
- 12.0 tpd of LNG @ -150°C/-238°F processing 620 Nm³/h or 0.6 MMSCFD.

Features

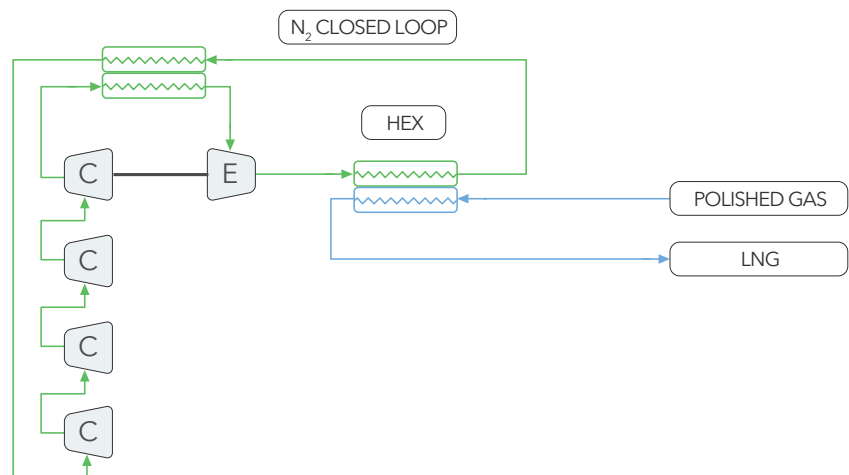
- **Compact & modular design** - skid/container (40-45 ft) with a flexible design to adapt to the user's available space, easy to transport, install and relocate.
- **Reliable** - separating the cooling media (nitrogen) and inlet feed gas ensures the maximum reliability by avoiding any contamination, corrosion and wear.
- **Efficient** - moderate energy consumption for liquefaction, with operating costs mainly due to power consumption.
- **Flexible** - possible to turndown the production of LNG to 40% of the maximum capacity and at desired LNG commercial specs (pressure and temperature).
- **Safe** - operational with self-generated nitrogen cooling media to avoid explosion or jet fire dangers. It can be used in classified or safe areas.
- **Complete** - containers come complete with insulation, lighting, air conditioning, doors and ventilation to facilitate operating activities.
- **Unmanned** - a remote control of process variables is provided, including web based access and proper database storage, allowing remote parameters control and proper maintenance scheduling. Plant data, including alarms, are available via OPC from the operator interface system (HMI).

Technical Information

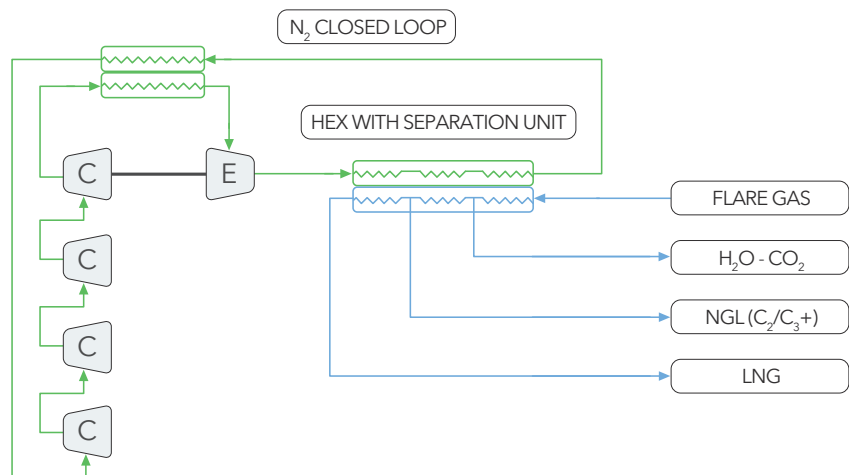
Process

The liquefaction system comprises fully integrated units that are consistent with specific processes and can be configured for any type of inlet gas (wet or dry gases).

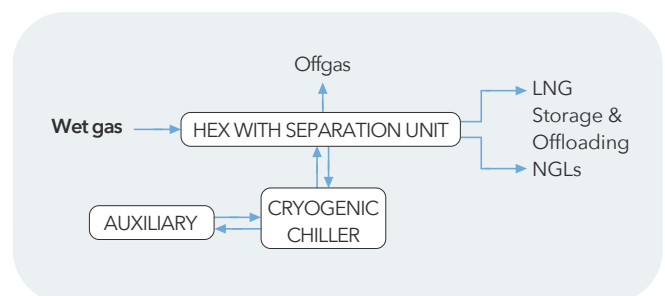
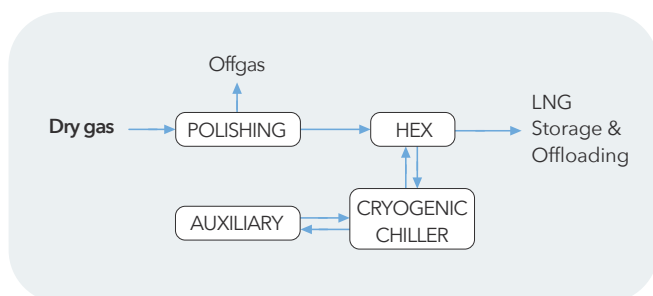
Dry gas (pipeline & well) liquefaction process



Wet gas (flare & well) liquefaction process



Flow diagrams



Natural Gas Liquefaction - LNG

Wet Gas	Dry Gas
Heat exchanger with separation unit to remove H ₂ O, CO ₂ , HHC from the inlet gas and producing NGLs and LNG from -160°C/-256°F to -150°C/-238°F	Polishing to remove H ₂ O and CO ₂ from the inlet stream
Auxiliary (Dry cooler or evaporative tower, methane pre-cooler, water chiller, water pumps)	Auxiliary (Dry cooler or evaporative tower, methane pre-cooler, water chiller, water pumps)
Cryogenic chiller self-production and chilling of the cooling media (nitrogen) to temperatures as low as -165°C/-265°F	Cryogenic chiller self-production and chilling of the cooling media (nitrogen) to temperatures as low as -165°C/-265°F
	Heat Exchanger unit to produce the LNG
Electrical/control room hosting plant PLC, inverters, power distribution, HMI	Electrical/control room hosting plant PLC, inverters, power distribution, HMI

Polishing

The polishing unit refines the purity of dry gas to ensure it meets stringent liquefaction specifications below 50 ppmv and 1 ppmv for CO₂ and H₂O respectively. To achieve this, the system employs **three fixed-bed adsorption columns**, which are filled with synthetic zeolites (specifically, 13X and 3A) that have been selected for their high selectivity and adsorption capacity. The three columns are operated in a staggered cycle, with one bed always in adsorption, one in regeneration and one in standby. This guarantees an **uninterrupted polishing process and minimises the risk of off-spec gas breakthrough**.

Each column undergoes a cycle comprising:

- 1) Adsorption phase
- 2) Desorption (regeneration) phase
- 3) Stand by (pressure equalization or idle)

Heat exchanger with separation unit

The heat exchanger with separation unit purifies the feed gas by removing excess H₂O, heavy hydrocarbons (HHC) and carbon dioxide. This equipment is a **special engineered heat exchangers** (shell & tube with drains) that, depending on the composition of the feed gas, performs the following functions:

- Deep drying out of moisture in icy form
- Extract an HHC blending (C5+, C4, C3 and C2) in liquid form
- Separate CO₂ in liquid/solid form
- Produce LNG

Technical Information

This unit comprises two sets of heat exchangers which operate alternately during cryogenic cooling. While one set is in operation, the other undergoes a regeneration phase to sublimate any accumulated water ice and/or CO₂ (dry ice) ensuring that the system remains efficient and highly resilient to inlet gas composition fluctuations.

The **heat exchanger with separation unit** ensures compliance with classified area regulations.

Cryogenic chiller

The cryogenic chiller unit provides cooling energy through a reverse Brayton cycle, utilizing nitrogen as refrigerant in a closed-loop system.

This cryogenic cycle (compression, cooling and expansion) lowers the temperature of the nitrogen below the liquefaction point of the gas stream allowing **LNG production** in the heat exchanger to the desired commercial standard for **transportation, bunkering and power generation**.

The cryogenic chiller unit is designed to avoid the need for an external nitrogen supply; any minor leakage in the circuits is automatically refilled by self-generation.



CO₂ Liquefaction - LCO₂

Description

Inlet stream from CO₂ capture:

- DAC (Direct Air Capture)
- DOC (Direct Ocean Capture)
- Exhaust gas
- Petrochemical process capture

The **CO₂ liquefaction system** is part of the solutions Ecospray provides to the customers **to support** their **decarbonization** journey. The system can be installed stand-alone or coupled with a carbon capture system, both for marine and land-based applications. From a carbon capture system, the **inlet CO₂** rich stream is **collected, "cleaned", dried and liquefied for industrial (99,5%), food or permanent sequestration applications (99,99%)**.

The liquefied CO₂ is then sent to the tank, where it remains until it is collected by the user according to the procedures set out under the international regulations. This process creates a **virtual pipeline**, connecting CO₂, emission sources and utilisation hubs **without** the need for **permanent physical infrastructure**.

Module production capacity:

- Pilot (upon request) from a minimum modular size of 1 tpd;
- Industrial scale application: up to 72 tpd module size.

Features

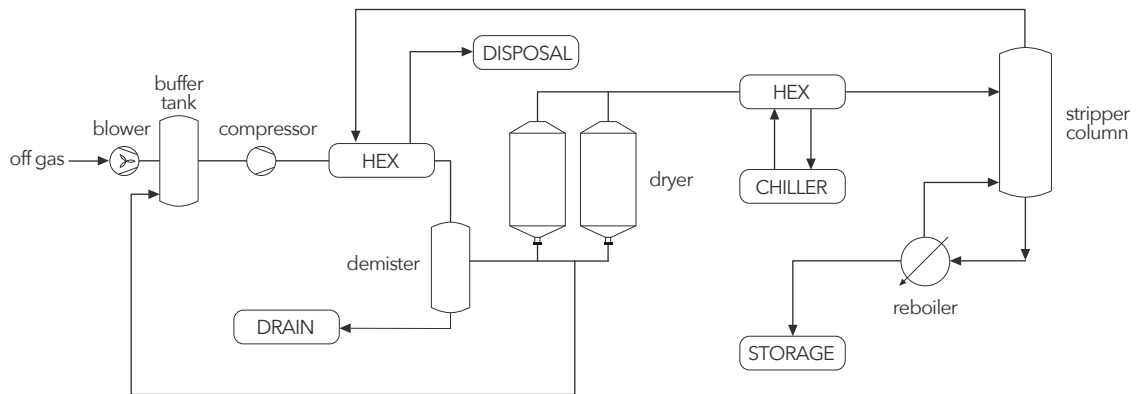
- **Compact & modular design** – skid/container (40-45 ft, horizontal or vertical footprint) with a flexible design to adapt to the user's available space, easy to transport, install and relocate.
- **Efficient** – moderate energy consumption for liquefaction, with operating costs mainly due to power consumption.
- **Flexible** – possibility of partializing the production of LCO₂ up to 50% of the maximum capacity and at desired LCO₂ commercial specs (grade, pressure and temperature).
- **Safe** – operational with no dangerous or unsustainable cooling media to avoid explosion or jet fire dangers. It can be used in classified or safe areas.
- **Complete** – containers come complete with insulation, lighting, air conditioning, doors and ventilation to facilitate operating activities.
- **Unmanned** – a remote control of process variables is provided, including web based access and proper database storage, allowing remote parameters control and proper maintenance scheduling. Plant data, including alarms, are available via OPC from the operator interface system (HMI).

Technical Information

Process

The process consists in an initial **purification** of the raw inlet gas to clean micro pollutants, followed by a **drying unit to remove the H₂O before the compression and cooling stage reaching the liquid phase.**

Furthermore, the liquified CO₂ - still industrial grade - is then sent in the **stripper tower to reach food or permanent sequestration grade**, collected at the bottom of the column.



Carbon Capture - CO₂

Description

Inlet stream for capturing CO₂:

- Exhaust engine gas
- Exhaust boiler gas
- Heat & power application (CHP)
- Petrochemical process

Decarbonization is a widely spread industrial target, and many types of industrial flue gas need to be treated.

Ecospray **CO₂ capture technology, based on chemical absorption with amines**, is considered one of the most effective and mature solutions, above all considering the reduction of the system's size while **optimizing energy consumption exploiting the thermal waste** already available.

Ecospray systems provide a viable solution also for diluted gas streams (CO₂<5%) thanks to the low heat required by the system for solution regeneration.

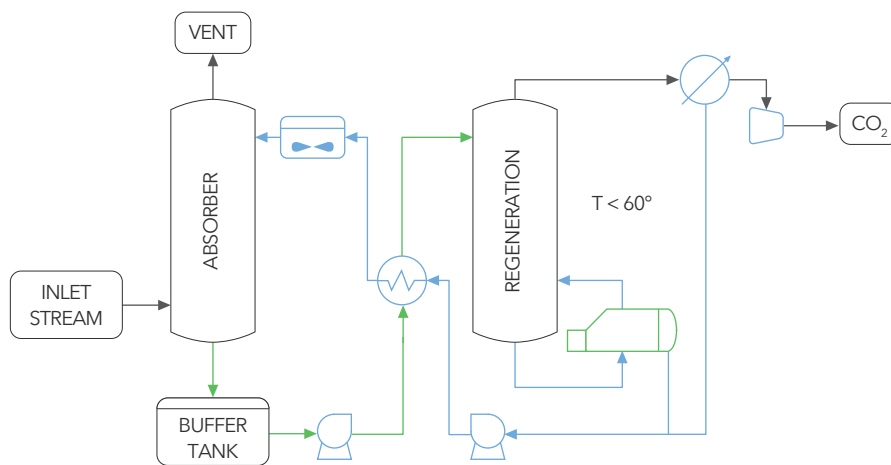
Ecospray's **carbon capture solutions** are tailored and engineered to **address specific industrial applications**, targeting exhaust emission goals - including the 2030 objective of <100 gCO₂/kWh for the 1-8 MW CHP.

Features

- **Compact & modular design** - skid and container (40-45 ft, horizontal or vertical footprint) with a flexible design to adapt to the user's available space, easy to transport, install and relocate.
- **Efficient** - lower energy consumption compared with standard amine capture systems thanks to low temperature regeneration allowing an extended amine lifecycle.
- **Flexible** - possibility of partializing the inlet flow down to 50% of the maximum capacity and at desired CO₂ capture ratio.
- **Safe** - operational with no high temperature dangerous for operators due to the low temperature of regeneration. It can be used in classified or safe areas.
- **Complete** - containers come complete with insulation, lighting, air conditioning, doors and ventilation to facilitate operating activities.
- **Unmanned** - a remote control of process variables is provided, including web based access and proper database storage, allowing remote parameters control and proper maintenance scheduling. Plant data, including alarms, are available via OPC from the operator interface system (HMI).

Process

The capturing process **is an amine solution absorption cycle**, featured by a low pressure, hence lower temperature, regeneration. This approach conserves energy by recovering heat from boiler or engine's cooling system possibly eliminating the need of additional fuel combustion (and associated CO₂ emissions). It also reduces or avoids the use of valuable high temperature thermal vectors in the case of combined Heat and Power (CHP) applications. **The released CO₂ can be used as it is, liquefied and stored in cryogenic tanks, or compressed in supercritical phase.**



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