LNG
LIQUEFIED NATURAL GAS TECHNOLOGIES
Air Liquide Group

The world leader in gases, technologies and services for Industry and Health

Air Liquide is present in 80 countries with approximately 67,000 employees and serves more than 3 million customers and patients. Oxygen, nitrogen and hydrogen are essential small molecules for life, matter and energy. They embody Air Liquide’s scientific territory and have been at the core of the company’s activities since its creation in 1902.

Air Liquide’s ambition is to lead its industry, deliver long term performance and contribute to sustainability.

Our full suite of technologies

- Liquefied Natural Gas
- Cryogenics
- Hydrogen
- Syngas
- Petrochemicals
- Natural Gas Treatment
- Sulfur
- Standard Plants
- Oleochemicals

Air Liquide Engineering & Construction

A technology partner of choice

Air Liquide Engineering & Construction builds the Group’s production units (mainly air gas separation and hydrogen production units) and provides external customers with efficient, sustainable, customized technology and process solutions.

Our core expertise in industrial gas, energy conversion and gas purification, enables customers to optimize natural resources.

We cover the entire project life-cycle: license engineering services / proprietary equipment, high-end engineering & design capabilities, project management & execution services. In addition we also offer efficient customer services through our worldwide set-up.

As a technology partner, customers benefit from our research and development to achieve energy transition goals.
Leader in cryogenics with more than 50 years in LNG

Air Liquide’s cryogenics technologies have been at the heart of the company for more than 110 years. Leveraging on this deep expertise, Air Liquide pioneered the LNG technology by supplying the process and core equipment for the first LNG base load plant in Algeria and with dozens of other LNG plants that followed in the next decades.

With the increasing demand for cleaner energy alternatives around the world, Air Liquide Engineering & Construction has reignited its LNG offer to accompany customers in their developments.
A complete suite of technologies from small to large scale

Air Liquide Engineering & Construction offers a comprehensive and unique suite of technologies for LNG liquefaction capable to propose to its customers the most adapted solution for small to large scale applications. It features:

- **Turbofin™**: Nitrogen cycle based on cryogenic turbo expanders best adapted to small scale size
- **Smartfin™**: Single Mixed Refrigerant cycle best adapted to small to mid size
- **Liquefin™**: Dual Mixed Refrigerant cycle best adapted to mid to large sizes

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LNG Production Capacity: 0.2 mtpa, 2.0 mtpa, 5.0+ mtpa

mtpa: million tons per annum

This family of solutions is based on Air Liquide proprietary processes using Plate Fin Heat Exchanger (PFHE), with Brazed Aluminum Heat Exchanger (BAHX) technology. This robust technology enables reaching higher efficiency and lower cost compared to the traditional Coil Wound Heat Exchanger (CWHE).

Air Liquide also owns a full spectrum of gas treatment solutions, such as NGL (Natural Gas Liquids) Recovery, Nitrogen Rejection, Acid Gas Removal and Sulfur Recovery, leveraging on the Cryogenics, Lurgi and Medal/PoroGen membranes technologies. This unique portfolio also enables Air Liquide Engineering & Construction to offer the most optimized LNG liquefaction solutions by providing best integrated schemes.

**Our strengths**

- Highly efficient and proven process solutions enabling to deliver reduced LNG production costs and plant emissions
- The use of the most cost effective technology for exchanger (BAHX), integrated into Cold Boxes designed to simplify construction at site and produced by Air Liquide Engineering & Construction in its own manufacturing centers
- The Air Liquide Group’s indisputable leadership in operating cryogenic plants... safety, reliability and operational simplicity
Our references

Air Liquide has successfully delivered more than 20 LNG trains all over the world. All these plants have excellent operational records testifying to the quality and performance in the long run of Air Liquide’s technologies.

From the first base load plants in Arzew and Skikda, Algeria, and the vast number of small scale LNG plant references in the Americas to a significant mid scale plant under construction in the Baltic region, Air Liquide teams have demonstrated their capabilities to deliver LNG plants using all types of technologies.
A full suite of services

Based on its network, Air Liquide Engineering & Construction can offer LNG solutions everywhere in the world. Our offer for LNG liquefaction plants besides the liquefier can include the gas pre-treatment as well as storages. It ranges from Engineering, Procurement and Construction for your LNG projects from early development stages to after sales services.

Our offer

- **Engineering:** Process Licensing, Feasibility studies including support to permitting, Pre-Front-End Engineering Design (FEED) and FEED, Detailed Engineering

- **Procurement:** Plant components and equipment based on Air Liquide Engineering & Construction global sourcing. Manufacturing of modules in Air Liquide Engineering & Construction own manufacturing centers (China, United Arab Emirates and France), in particular the cryogenic Cold Boxes

- **Construction:** Technical assistance including commissioning. For small size plants, Air Liquide Engineering & Construction can also deliver turnkey solutions

- **After sales support:** Training, plant audit, plant revamping and upgrade, operation assistance
Tailored for our customers

Our solutions for LNG are tailored and optimized to your application from LNG export terminals to plants dedicated to the emerging use of LNG as a fuel for transport (such as marine, road and rail) or for small remote power applications.

Air Liquide Engineering & Construction technologies will enable you to reduce plant emissions to make LNG an even cleaner power solution and help to further accelerate its role in the global energy transition.
Nitrogen Refrigerant Technology

Our Nitrogen Refrigerant technology is adapted for small to mid scale plants. Our solution is easy to operate and provides the assurance of high quality and safety, with a low capital investment.

For small scale LNG, Air Liquide Engineering & Construction offers a fully standard and modularized product using the Turbofin™ technology. This enables to deliver cost competitive plants with a very short delivery time.

Advantages:

- Cost effective, especially for small scale
- Non-hydrocarbon refrigerant improving safety
- Simplicity of operation
**Turbofin™ technical snapshot**

- **Turbofin™ solution** uses a Brazed Aluminium Heat Exchanger fitted into a compact Cold Box and Turbo-Expander as key equipment.
- The fluid used in the single refrigeration cycle is Nitrogen.
- Nitrogen is compressed, precooled and let down in two stages through two expanders coupled with compressors (Turbo-Expander).
- The work generated by the expansion is recovered to contribute to the compression of the Nitrogen.
- The let-down of Nitrogen generates cooling duty that is exchanged in the Cold Box and allows Natural Gas pre-cooling, liquefaction and sub-cooling.
Air Liquide Engineering & Construction’s Single Mixed Refrigerant technology provides an efficient process for small to mid scale plants. This technology is commonly used in the LNG industry for peak shaving facilities and is the preferred technology for mid scale plants.

Advantages:

- Efficient process
- Flexibility of operation
- Reduced number of rotating machines
- Compact and modular design using Brazed Aluminium Heat Exchanger
**Smartfin™ technical snapshot**

- Smartfin™ solution uses Brazed Aluminium Heat Exchanger fitted into a compact Cold Box as key equipment.
- The fluid used in the single refrigeration cycle is a mixture of refrigerant (MR).
- MR is compressed through a compressor, cooled and partially condensed. The lighter part of the MR in vapor state and the condensed heavier part are introduced separately into the Cold Box.
- They are then pre-cooled and let down separately, generating the cooling duty that allows for Natural Gas pre-cooling, liquefaction and sub-cooling.
- The MR fraction that condenses in the intermediate compression stage is also introduced in the Cold Box to contribute to the refrigeration process.
Dual Mixed Refrigerant Technology

Liquefin is a Dual Mixed Refrigerant (DMR) technology originally developed by IFPEN and AXENS and already validated by the market. It is now owned by Air Liquide. Liquefin is a highly efficient process and provides the most cost competitive LNG product per ton. The technology is optimized best with the Brazed Aluminium Heat Exchanger, leading to further cost reductions and scalable output.

Advantages:

- Highly efficient process
- Optimized for the use of Brazed Aluminium Heat Exchanger
- Compact and modular design
- Balanced refrigeration power allowing for identical refrigerant compressor drivers
- Very cost effective solution
**Liquefin™ technical snapshot**

- Liquefin™ solution uses a Brazed Aluminium Heat Exchanger fitted into a compact Cold Box as key equipment.
- Two refrigeration cycles are used in this process, each using a dedicated mixture of refrigerant.
- The first cycle is filled with a fluid composed of relatively heavy components (HMR). The second cycle uses a fluid made of lighter components (LMR).
- Each HMR and LMR fluid is compressed through a compressor, cooled and introduced in the Cold Box under a single phase.
- The HMR is then let down in several stages, generating the cooling duty that pre-cools the Natural Gas and condenses the LMR.
- The LMR is then also let down, generating the cold duty that allows for Natural Gas liquefaction and sub-cooling.
Equipment & Manufacturing

Brazed Aluminium Heat Exchanger, a proven technology for LNG

- Brazed Aluminium Heat Exchanger (BAHX) is a first choice technology in the LNG industry, demonstrated by a large number of running references.
- Aluminium offers a negligible resistance to heat transfer. The plate-fin assembly gives an incomparable surface exchange by volume (over 2000m²/m³) and allows for multiple fluids exchange in a single piece of the exchanger. The combination brings significant cost savings compared to other technologies.
- For decades, Air Liquide has been designing and operating BAHX for its cryogenics plants. Air Liquide Engineering & Construction’s offer in LNG embeds this exceptional experience.
- BAHX allows for a compact and modular design.

Mastering Cold Boxes

- Air Liquide Engineering & Construction is fully mastering Cold Boxes engineering cycle. We are designing the Cold Boxes and constructing them in our manufacturing centers of Ras Al Khaimah (United Arab Emirates), Vitry-sur-Seine (France) and Hangzhou (China).
- Cold Boxes allow very compact layout, housing BAHX with connecting pipings and instruments, and offer a highly efficient thermal insulation – without maintenance needed – to the cryogenic process.
- On-site work around this key item is very limited making construction a very quick and simple step.
Customer commitment

Evolving with you

Continually stepping up our game
When you turn to us for small to large scale LNG plants, we offer more than just the equipment. Ingrained in our DNA is over a century of leadership in developing and improving cryogenic distillation and advancing liquid Natural Gas technologies. In addition to offering expert consultation, we also learn from you.

This exchange of ideas and information allows us to provide you with state-of-the-art plants designed to optimize your investment. Our expert project teams work in lock step with you to ensure timely and efficient installation and implementation of every unit we sell.

Safety at the forefront of all our activities
Air Liquide Engineering & Construction always operates with safety and never put at risk the health and the environment of our professionals, customers, business partners and surrounding communities. We understand that safety is part of the business and an important part of the success of each project.

Safety is an uncompromising value – we believe that all injuries are preventable with the goal of zero accidents and environmental incidents.

We grow from our experience in working with you.
For more information, please contact: lng@airliquide.com