Air Liquide
ENGINEERING & CONSTRUCTION

Cryogenics & Lurgi technologies

Electronics Carrier Gas Yard

Best in class, safe, reliable and energy efficient technology solutions

Air Liquide Group

A world leader in gases, technologies and services for industry and healthcare

Air Liquide is present in 60 countries with 66,500 employees and serves more than 4 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 Group's activities since its creation in 1902.

Taking action today while preparing the future is at the heart of Air Liquide's strategy. With ADVANCE, its strategic plan, Air Liquide is targeting a global performance, combining financial and extra-financial dimensions. Positioned on new markets, the Group benefits from major assets such as its business model combining resilience and strength, its ability to innovate and its technological expertise.

The Group develops solutions contributing to climate and the energy transition—particularly with hydrogen—and takes action to progress in areas of healthcare, digital and high technologies.

Air Liquide Engineering & Construction

A technology partner of choice

Air Liquide Engineering & Construction builds the Group's production units (mainly air gas separation and renewable/low carbon Hydrogen) 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.

Powered by our suite of Technologies

Air Liquide Engineering & Construction provides all technologies to supply ultra high purity carrier gases generated on-site, including nitrogen, oxygen, argon, hydrogen, carbon dioxide and other rare gases in bulk.

Electronics:

On-site Carrier Gas Production Solutions

- **Small to large nitrogen generators (with argon, oxygen co-production)**
- **Ultra high purity oxygen generators**
- **Balance of Plant: back up systems, purifiers, analyzer cabinets, quality controls**
- **Other Technologies: hydrogen generators and turboexpanders**
- **High pressure CO_2 technologies**

5
Manufacturing centers

17
Operating centers & front-end offices

183
Patent applications filed in 2023

Advancing for a sustainable future

Air Liquide is deeply committed to creating a positive impact on both the environment and society. Our strategy and actions are designed to address crucial challenges the world faces today, where we can make an impact and thus invent a sustainable future.

Climate, health, energy, mobility, sovereignty, the digital revolution... There are many global societal challenges that call for immediate – and collective – responses.

At Air Liquide, we are ready.
Ready to deploy our solutions wherever they are needed, and ready to accelerate whenever the situation requires it. Whether it is supporting our customers on their decarbonization journey, deploying hydrogen to make mobility more sustainable, or contributing to the growth of digital technologies, we offer concrete solutions to help society move forward.

To reduce our own CO_2 emissions, we have set key milestones to reach carbon neutrality:

- by 2025, -30% reduction in carbon intensity
- by 2035, a -33% reduction in absolute Scopes 1 & 2 emissions
- by 2050, reach carbon neutrality across the entire value chain.

Air Liquide's suite of technologies and gas services for the electronics industry have been well proven for more than 50 years

Value proposition for our customers

At Air Liquide, we deliver ultra-high purity gases to the electronics industry, combining on-site production, backup solutions, other technologies such as hydrogen generators and cryogenic liquid storage to create the most efficient and cutting-edge technology solution.

Manufacturing electronic devices in ultra clean environments is crucial, and our ultra-pure gases—nitrogen, oxygen, argon, hydrogen, helium, carbon dioxide, and rare gases—ensure the cleanliness and stability of your processes. Whether supplied in bulk, via pipeline, or produced directly on-site, we tailor our solutions to your specific needs.

- **Our nitrogen generation systems are designed for flexibility and reliability,** offering modular configurations with customizable flow rates, purity levels, and pressures. Leveraging proprietary, energy-efficient cryogenic separation technology, we help you meet sustainability goals by minimizing power consumption.
- **We maintain stringent quality control over our carrier gases**, ensuring they meet the highest standards demanded by electronics manufacturers. With short lead times, standardized products, and flexible installation options, we quickly adapt to your project requirements, whether on-site or off site. Additionally, we leverage our extensive gas supply chains to move swiftly in response to project needs and to scale alongside the growth of your facilities.
- **Backed by decades of experience**, we guarantee safety, quality, reliability and efficiency in every solution we provide, drawing on our global engineering expertise to ensure operational excellence and flawless execution of sourcing and distribution.

Our range of technologies

Air Liquide's nitrogen generator technologies for the electronics market enable the production of large volumes of ultra-pure nitrogen, argon, and oxygen with best-in-class efficiency.

Nitrogen On-site units: TCN™

Since its creation in the 1970s for oil and gas, TCN™ (Teisan Compact Nitrogen) technology has continuously evolved to meet the stringent and changing demands of the electronics market.

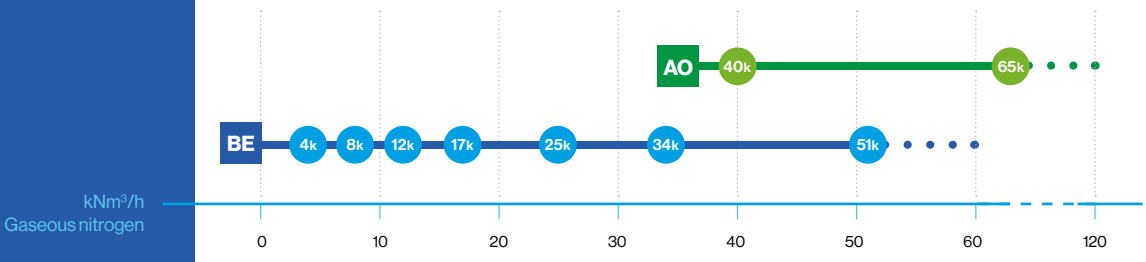
Today, our TCN™ series offers flexible options for scale, configuration, and purity (from parts per million to parts per billion), ensuring energy efficiency and competitive capital investment tailored to customer needs.
Combined with backup solutions and cryogenic storage, we guarantee long-term reliability and flexibility.

Our nitrogen product portfolio is divided into two main series, "Best Energy - BE" and "Argon Oxygen - AO" producing between 4,000 Nm^3/hr (4k Nm^3/h) to 65,000 Nm^3/hr (65k Nm^3/hr) of gaseous nitrogen.

Air Liquide references by production flow

Our TCN™ units are suitable for flow rates exceeding 4,000 Nm³/hr of gaseous nitrogen with purity levels above reaching ppb level. Integrated to our TCN™ units, oxygen on-site units (UPO) can generate ultra-high purity liquid oxygen in flow ranges from 120 to 600 Nm³/hr, providing a versatile and efficient solution. Industrial grade oxygen production can also be produced as a customized solution.

Nitrogen Product Portfolio for EL - TCN™ (Teisan Compact Nitrogen)



Air Liquide TCN™ references

>100

TCN™ units delivered (since 2011)

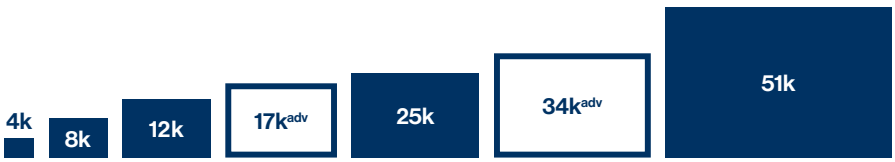
Our range of technologies

TCN™ - Best Energy series

The TCN-BE series is our most energy-efficient nitrogen generation solution, capable of producing nitrogen from air while also generating valuable oxygen as a co-product.

The TCN-BE series offers flexible configurations for product supply pressures (up to 9.5 BarG) and purity levels, ranging from parts per million to parts per billion. With an average availability of over 99%, it ensures reliable performance and features automatic plant operation, delivering a seamless, energy-efficient solution.

The TCN™ BE product portfolio presents several sizes aligned on the maximum expected capacity of gaseous nitrogen (from 4,000 to 51,000 Nm^3/hr).

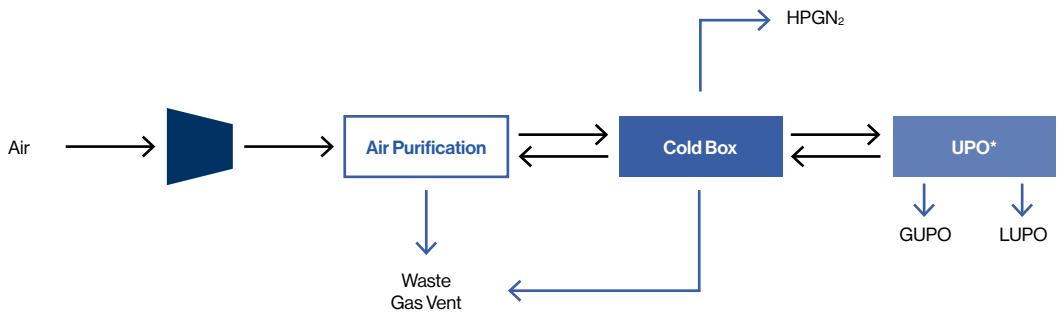


TCN™ - BE17K ADVANCED and BE34K ADVANCED

The TCN-BE17 Adv. and BE34 Adv. models are built on the successful principles of the BE series.

By adding the following features:

- Fully modularized solution
- Fully standardized product (faster delivery)
- Optimized design for high purity (ppb) and high pressure (9.5 barG)
- Adaptable in key geographies



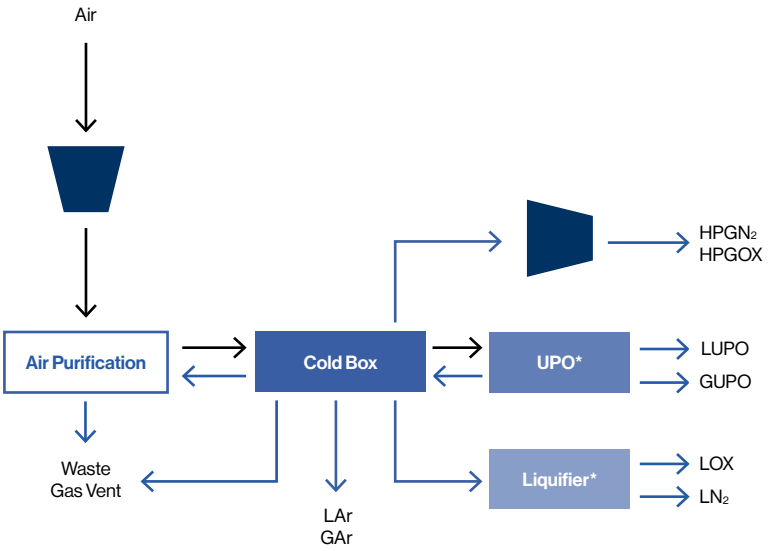
* OPTION :
$HPGN_2$: High Pressure Gaseous Nitrogen
LN_2 : Liquid Nitrogen
GUPO : Gaseous Ultra Pure Oxygen
LUPO : Liquid Ultra Pure Oxygen

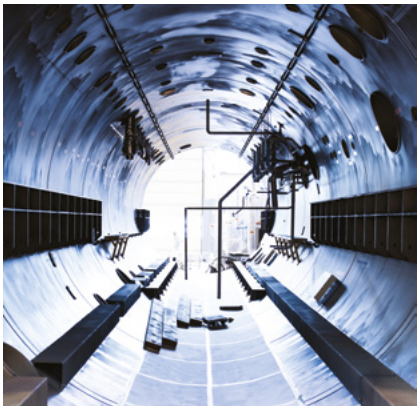
TCN™ - Argon Oxygen series

The TCN-AO series provides a comprehensive carrier gas solution for large consumers, producing nitrogen, oxygen, and argon in both liquid and gaseous states through cryogenic air distillation.

This system offers best-in-class efficiency for nitrogen production while meeting the growing demand for argon and oxygen.
To reduce lead times and enhance consistency, the TCN-AO features a modular design, divided into distinct warm and cold sections. Products are supplied at a pressure up to 9.5 BarG, with purity levels ranging from parts per million to parts per billion, depending on the specific product requirements.

With an average availability of over 99%, the TCN-AO series ensures reliable performance and includes automatic plant start-up and operation for optimal efficiency.

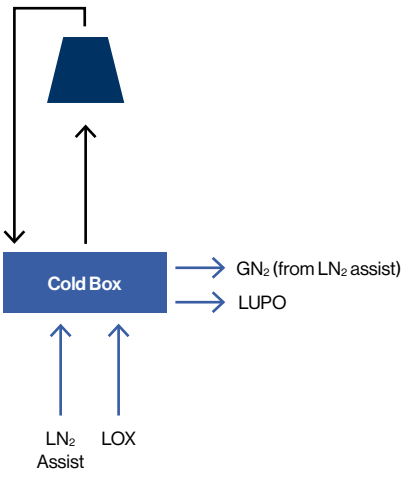




UPO - Ultra Pure Oxygen solutions

Our UPO system produces ultra-pure oxygen (greater than 99.5% oxygen) at high pressure (above 9.5 barG) and offers three flow rate options through distillation at cryogenic temperatures.

It can be seamlessly integrated into our TCN™ BE and AO processes or operate as a stand-alone solution using third-party liquid oxygen as feedstock, providing flexible and efficient solutions for your oxygen needs.



UPO Stand alone

* OPTION

Our range of technologies

Backup systems

Our cryogenic liquid vaporization systems consist of cryogenic liquid storage tanks, vaporizers, piping, and valves.

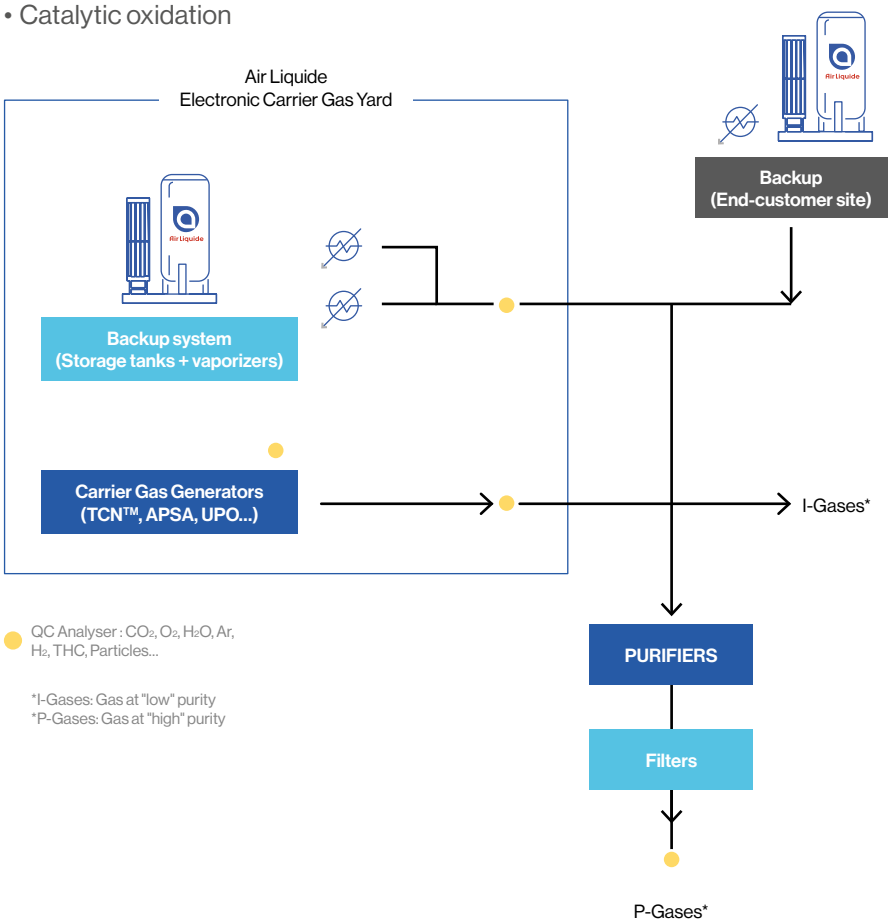
These systems provide reliable backup for gas delivery during total or partial production outages, or any event where the TCN™ cannot fully meet customer demand, ensuring uninterrupted gas supply.

Purifiers / Analyser cabinets

Our customized solution to offer purifiers generate ultra-high purity gases (below part per billion) — nitrogen, oxygen, argon, hydrogen, helium, and carbon dioxide — at pressures between 7 and 8.5 barG, with flow rates from 1 to ~20 k Nm³/h

The purification process is using one or a combination of these mechanisms, based on the gas type and target impurities:

- Physical adsorption
- Chemical adsorption
- Catalytic oxidation
- Membrane
- Cryogenic adsorption



Quality controls

Drawing on decades of expertise, we implement comprehensive quality control systems to maintain the highest standards throughout production:

- **Import Quality Control (IQC):** Monitors the quality of the gases imported and going out from the back up system.
- **Operating Quality Control (OQC):** Monitors the good operation and stability of our nitrogen gas generators.
- **Continuous Quality Control (CQC):** These final checkpoints guarantee that finished products meet all specifications before reaching consumers, ensuring quality and reliability.

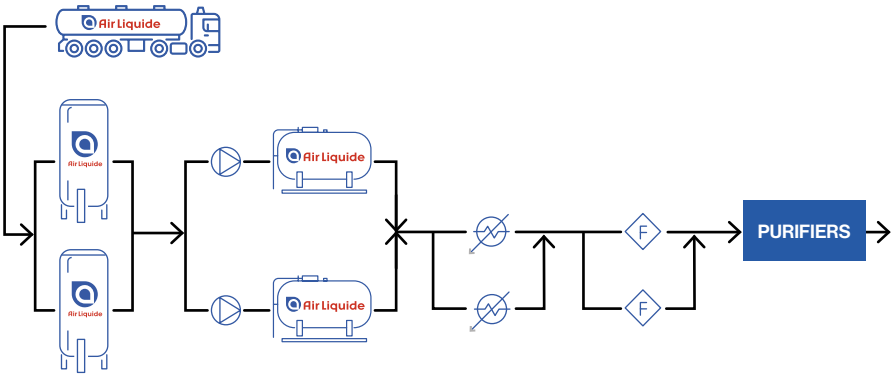
$HPCO_2$

$HPCO_2$ supply system is used for a special drying process in the Integrated Circuit manufacturing process. Air Liquide is recognized as a trusted supplier of the $HPCO_2$ system to electronics customers.

The system process involves:

- LCO_2 pumped to sub-critical pressure, then vaporized at high pressure to reach downstream purification at 9N (< 1ppb impurities)
- A sensitive pressure/temperature control set up to avoid CO_2 liquefaction during transfer.

$HPCO_2$ Permanent solution



Our experience

Air Liquide is expanding investments in major semiconductor fabrication facilities and providing innovative proprietary nitrogen generation systems and carrier gas yard solutions to support customers.

Developing innovative solutions for Global Foundries to improve competitiveness and energy efficiency

As part of Air Liquide's long-lasting partnership with GlobalFoundries, a leading semiconductor manufacturer, Air Liquide is investing €50 million to build a state-of-the-art plant in Singapore and upgrade existing facilities, to supply high-purity nitrogen to GlobalFoundries.
The new Singapore plant will reduce energy consumption and is set to be operational by 2026. Additionally, a 15-year renewal of Air Liquide's partnership will support energy-efficient upgrades at GlobalFoundries' New York site, aligning with the company's goal to reduce greenhouse gas emissions by 25% by 2030.

Semiconductor Plants Development in Taiwan

Air Liquide is investing €500 million to build three advanced gas production plants in Taiwan, to supply two of the world's largest semiconductor manufacturers with large volumes of ultra high purity gases.
These state-of-the-art facilities, located near customer sites, will produce up to 2 billion Nm^3 of ultra-pure nitrogen, oxygen, and argon annually.
With these investments, Air Liquide is strengthening its presence in the area and reinforcing its partnership with two long-term leading players in the electronics industry.

We provide a highly innovative suite of proprietary nitrogen generation systems and carrier gas yard solutions, designed to support and advance our customers' operations with reliability and efficiency.

Supporting the semiconductor industry in the U.S.

Air Liquide is investing over $250 million to build a new state-of-the-art gas production facility in Idaho, U.S., to supply ultra-pure gases to Micron Technology, one of the world's leading semiconductor manufacturers.
This innovative plant is part of a complete carrier gas solution designed by Air Liquide, with an optimized land footprint and competitive total cost of ownership.
Set to be operational by late 2025, it will provide large volumes of high purity industrial gases for the production of memory chips. The use of digital technologies, standardization and modularization will bring exceptional value to local customers in terms of reliability, short delivery time and efficient project execution.

Strengthening Air Liquide's presence in the Japanese electronics sector

Air Liquide is investing more than €300 million in four state-of-the-art gas production plants in Japan to supply ultra-high purity gases to two major semiconductor manufacturers.
These state-of-the-art facilities, located near customer sites, can produce up to 1,5 billion Nm^3 of ultra-pure nitrogen, oxygen, and argon annually, and will also enable the Group to avoid the emission of about 35,000 tons of CO_2 per year, equivalent to the CO_2 emissions associated with the yearly electricity use of 11,000 Japanese households.

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