Modular air separation plants.
Proven technology offering cost and schedule gains.
Meeting today’s gas supply challenges in air separation.

Companies considering investing in air separation units need to balance a number of factors. A reliable design offering minimal technical risk and maximum operational flexibility is essential to ensure process continuity and meet stringent safety standards. Construction logistics and implementation timeline can also be key considerations, particularly in areas that are difficult to access. In addition, plant owners face a number of financial constraints. Rapid return on investment is essential in today’s increasingly competitive economic climate. Companies must look at both capital and operating expenditure (CAPEX and OPEX) over the entire plant lifetime to ensure a realistic assessment of total cost of ownership.

Modular design for time, cost and reliability gains

Linde is one of the largest and most experienced suppliers of air separation plants and industrial gases worldwide. We have delivered over 3,000 air separation plants around the globe and operate more than 400 air separation units (ASUs) ourselves. Building on our long experience in plant engineering and operation, we have developed a portfolio of modular air separation units to meet today’s ASU challenges. These plants provide the best solution for our clients’ varied needs, offering:

↑ Rapid time-to-solution through extensive prefabrication and pre-testing
↑ Simplified on-site logistics and lower CAPEX thanks to modular design
↑ Fast-track equipment fabrication and delivery
↑ State-of-the-art technology and design for reliable operation
↑ Ease of maintenance for low OPEX
↑ Professional support services from consulting to commissioning and start-up
↑ High power efficiency through proprietary process development
↑ Peace of mind thanks to our strong focus on, and excellent track record in, quality, health, safety and environmental (QHSE) protection

Industry-proven expertise

We serve clients across a broad range of industries. The hands-on experience we have gathered enables us to recommend, design and deliver the perfect fit for individual needs – regardless of the industry you operate in. Our references span:

Metals
• Iron and steel
• Non-ferrous metals including gold, copper, nickel, lead and zinc
Chemicals
• Ethylene oxide, ammonia synthesis, petrochemicals
Energy and gasification
• IGCC, biomass and coal gasification, oxyfuel, natural gas, synthetic fuel, partial oxidation, coal-to-liquid, gas-to-liquid
Electronics
• Electronics, semiconductors, solar cell panels
Other industrial gases applications
• Healthcare
• Food processing
• Glass
• Pulp and paper
• Environmental technology, etc.

“Understanding our customers’ needs, offering a value-creating solution and executing are key capabilities at Linde Engineering.”

Jürgen Nowicki
Managing Director
Member of the Board of Directors
Linde Engineering Division
Our oxygen plant portfolio – meeting your individual needs.

At Linde Engineering, we understand that technical requirements vary from one industry to another. We have developed a range of modular oxygen units so you can match your investment to your defined supply needs.

Oxygen plants at a glance
Modular plant solutions with a maximum degree of prefabrication

- **LINOX™** Liquid production plants for bulk gas supply
- **IMPACT™** Gaseous and liquid production plants for on-site and bulk gas supply
- **SCALE™** Tonnage plants for on-site and bulk gas supply
- **ECOGOX™** Low-purity gaseous production plants for on-site supply

Extended portfolio complementing our modular offering
- **VPSA** Vacuum pressure swing adsorption plants
- **Customized plants** Tailor-made plants

-15% average power consumption of our ASUs over the last 10 years

Read more: leamerica.com/adsorption leamerica.com/air_separation

**GOX flow [Nm³/h]**

- < 10,000
- 4,000–9,000
- 9,000–150,000
- 25,000–75,000
- 2,000–9,000
- 2,000–9,000
- 25,000–75,000
- 3,000–25,000

**High-purity applications**

**Low-purity applications**
Modular air separation plants

IMPACT 12 in Russia.

SCALE 30 in China.
Our nitrogen plant portfolio – the perfect match.

One size does not fit all. We know that technical requirements can vary significantly from one market segment to another. Our nitrogen offering ranges from low-volume models up to high-flow units and even includes a specially developed range for ultra-high-purity needs, so you can always be sure that you get precisely what you need – no more and no less!

**Nitrogen plants at a glance**

Modular plant solutions with a maximum degree of prefabrication

- **SPECTRA™** Delivering highest purity levels for the electronics industry
- **ECOGAN™** General applications with industrial purity levels
- **NLU** Nitrogen liquefaction units

Extended portfolio complementing our modular offering

- **PSA** Pressure swing adsorption plants
- **Customized plants** Tailor-made plants

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1 ppb nitrogen purity ex cold box

Read more: leamericas.com/adsorption
leamericas.com/air_separation
Proven track record for predictable project outcomes
Having delivered over 4,000 industrial plants worldwide, we have a long-standing, proven track record as a leading engineering, procurement and construction (EPC) partner. Our global procurement and construction capabilities give you the best of both worlds by combining our international reach with local market advantages and synergies. Project-specific execution models package these capabilities into customized workflows, building on state-of-the-art technologies for lowest total cost of ownership. Skilled and experienced commissioning teams ensure smooth start-up and hand-over. We also offer expert global support – either remotely or through our on-site teams.

Cost and time efficiencies
Our modular plant concept, which includes extensive prefabrication and pre-testing of key modules, combined with Linde standard specifications, greatly accelerates your on-stream times. Additionally, these plants permit remote operation. Local staff are only required for plant start-up, routine checks and maintenance, thus contributing to the reduction in lifecycle costs.

Designed for reliability and availability
We design and manufacture all key cryogenic components in-house to ensure the highest standards of performance and quality. Our availability and reliability concept is based on a fully functional split of the overall supply system into the air separation plant and the backup unit. This split achieves reliability levels very close to 100 percent. Sophisticated interlock functions protect the plant against unforeseen failures or operator errors and keep the plant in a safe condition even in the event of a power failure.

Prefabrication for rapid solution
- Plate-fin heat exchangers in self-supporting steel casings
- Columns in self-supporting steel casings
- Cold box sizes designed for road transport
- Molecular sieve valves on skids
- Cryogenic pumps on skids
- Plant control system in air-conditioned, pre-wired and shop-tested container
- Electrical medium-voltage switch gear in shop-assembled container

Very close to 100% level of reliability

Remote Operating Center (ROC).
“Our people, operational excellence and patented technologies empower us to deliver value to our customers.”

Dr Christian Bruch  
Member of the Executive Board of Linde AG
Linde Engineering.

Facts and figures.

Our air separation business.

Composition of air

<table>
<thead>
<tr>
<th></th>
<th>Vol %</th>
<th>Boiling point</th>
</tr>
</thead>
<tbody>
<tr>
<td>O₂</td>
<td>20.95</td>
<td>-183.0°C*</td>
</tr>
<tr>
<td>N₂</td>
<td>78.08</td>
<td>-195.8°C*</td>
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<tr>
<td>Ar</td>
<td>0.93</td>
<td>-185.9°C*</td>
</tr>
<tr>
<td>Ne</td>
<td>0.0018</td>
<td>-246.1°C*</td>
</tr>
<tr>
<td>He</td>
<td>0.0005</td>
<td>-268.9°C*</td>
</tr>
<tr>
<td>Kr</td>
<td>0.00011</td>
<td>-153.2°C*</td>
</tr>
<tr>
<td>Xe</td>
<td>0.00009</td>
<td>-108.0°C*</td>
</tr>
</tbody>
</table>

Number of patents

150 new air separation patents in last 5 years

3,000+ air separation plants have been built by Linde

400 air separation units owned and operated by The Linde Group

World’s largest single train air separation unit built by 5,250 tpd oxygen

1902... World’s first air separation unit for oxygen production

1990... Linde introduced argon production by rectification.
Modular air separation plants

19% TCO (Total Cost of Ownership)

-15% average power consumption of our ASUs over the last 10 years

Linde air separation units built in more than 90 countries

Biggest prefabricated cold box:

Heat exchanger

1,700 m²/m³ max. surface

Height 70 m
Weight 800 t

Read more: leamercas.com/air_separation
Collaborate. Innovate. Deliver.

Linde’s Engineering Division is a leading player in the international plant engineering business. Across the globe, we have delivered more than 4,000 plants and cover every step in the design, project management and construction of turnkey industrial facilities. Our proven process and technology know-how plays an indispensable role in the success of our customers across multiple industries – from crude oil, natural gas extraction and refining to chemical and metal processing.

At Linde, we value trusted, lasting business relationships with our customers. We listen carefully and collaborate closely with you to meet your needs. This connection inspires us to develop innovative process technologies and equipment at our high-tech R&D centers, labs and pilot plants – designed in close collaboration with our strategic partners and delivered with passion by our employees working in more than 100 countries worldwide.

From the desert to the Arctic, from small- to world-scale, from standardized to customized builds, our specialists develop plant solutions that operate reliably and cost-effectively under all conditions.

You can always rely on us to deliver the solutions and services that best fit your needs – anywhere in the world.

Discover how we can contribute to your success at www.leamericas.com

Get in touch with our team:
Phone: +281.717-9090, e-mail: sales@leamericas.com

Core competencies at a glance

Plant engineering
→ Air separation plants
→ LNG and natural gas processing plants
→ Petrochemical plants
→ Hydrogen and synthesis gas plants
→ Chemical plants
→ Adsorption plants
→ Cryogenic plants
→ Carbon capture and utilization plants
→ Furnaces, fired heaters, incinerators

Component manufacturing
→ Cold boxes and modules
→ Coil-wound heat exchangers
→ Plate-fin heat exchangers
→ Cryogenic columns
→ Cryogenic storage tanks
→ Liquefied helium tanks and containers
→ Air-heated vaporizers
→ Water bath vaporizers
→ Spiral-welded aluminium pipes

Services
→ Revamps and plant modifications
→ Plant relocations
→ Spare parts
→ Operational support, troubleshooting and immediate repairs
→ Long-term service contracts
→ Expert reviews for plants, operations and spare part inventory
→ Operator training