

ECOVAR®

Leading on-site gas supply solutions.
Increased reliability and professional support.



THE LINDE GROUP

Linde



Global availability, total supply reliability. The ECOVAR[®] concept.

Linde is a globally active gas and engineering company that supports customers in over one hundred countries around the world with gases, applications know-how, extensive services and state-of-the-art hardware. Looking back on 130 years of excellence, reliability and innovation, we continue to expand our global presence every year. Our strength comes from more than 50,000 committed, highly motivated employees, each of them a well-trained expert in his or her field.

Actively keeping contact with our customers to adapt our technologies even better to their requirements, we focus our efforts on improving quality and safety, and enhancing productivity while lowering negative impacts on the environment. In other words: no matter how big or small your company is, if you apply gases, gas-related technology or equipment to make your products and/or your processes work, Linde is the reliable one-stop solution provider that can help you meet the demands of today's highly competitive markets.

The ECOVAR[®] concept from Linde is the solution of choice for a broad range of industries that require continuous, if sometimes fluctuating, amounts of high-quality gases. With our ECOVAR[®] on-site supply solutions, we ensure a continuous, monitored and flexible gas supply directly at the customer's site. For the on-site production of oxygen, nitrogen and hydrogen, we combine standardised components which are cost-efficiently adapted to the specific demands on location.

Due to the modular design of our ECOVAR[®] on-site supply solutions, the costs of development, production and installation can be significantly reduced. Through optimal combination of the production plant and its corresponding back-up unit, ECOVAR[®] offers an extremely high level of flexibility and reliability, at low investment and operational costs. You benefit from our know-how in on-site plant project planning and plant operation – for your entrepreneurial success.

More than 1,000 ECOVAR[®] sites worldwide.



Application:
Oxy-fuel furnace firing
Location:
USA
ECOVAR[®] solution:
CRYOSS[®]-0
Capacity:
2 x 4,000 Nm³/h oxygen
Installation date:
2000



Application:
Pulp bleaching
Location:
Chile
ECOVAR[®] solution:
ADSOSS[®]-0
Capacity:
2,200 Nm³/h oxygen
Installation date:
2006



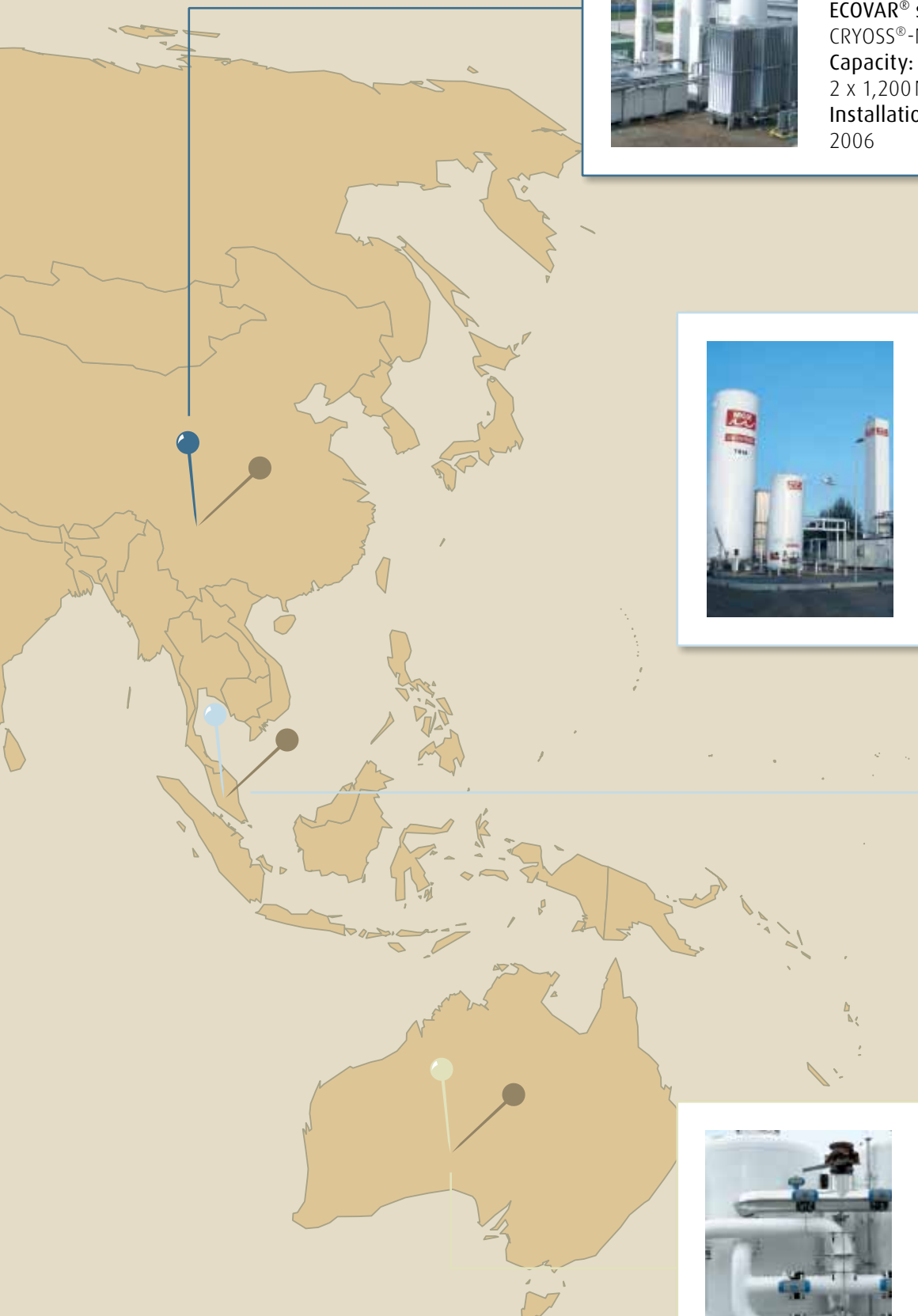
Application:
Float furnace atmosphere
Location:
Russia
ECOVAR® solution:
HYDROSS®-E
Capacity:
2 x 60 Nm³/h hydrogen
Installation date:
2005



Application:
Float furnace inerting
Location:
Germany
ECOVAR® solution:
CRYOSS®-N
Capacity:
2,200 Nm³/h nitrogen
Installation date:
2006



Application:
Metal heat treating
Location:
India
ECOVAR® solution:
CRYOSS®-N
Capacity:
450 Nm³/h nitrogen
Installation date:
2009



Application:
Process inerting/
tank blanketing
Location:
China
ECOVAR® solution:
CRYOSS®-N
Capacity:
2 x 1,200 Nm³/h nitrogen
Installation date:
2006



Application:
Semiconductor production
Location:
Malaysia
ECOVAR® solution:
CRYOSS®-N
Capacity:
2,600 Nm³/h nitrogen
Installation date:
2007



Application:
Mineral extraction
Location:
Australia
ECOVAR® solution:
ADSOSS®-O
Capacity:
400 Nm³/h oxygen
Installation date:
2008



We take care of your supply.

Our strengths become your advantages.

100% reliability for on-site customers

Our customers' production processes demand nothing less than a 100% reliable gas supply. This demand is met by all ECOVAR® on-site supply solutions. From telemetric plant monitoring at Linde's remote operation centres around the world to fail-safe, automatic backup supply of bulk product stored at the site, Linde provides full security of supply for its on-site customers.

Low costs, low risks, full service

Through the use of an ECOVAR® on-site supply solution from Linde, industrial gas consumers are able to gain the advantage of a lower-cost gas supply while avoiding the capital investment required, allowing them to focus their capital resources on their primary business needs. Rather than dedicating efforts to gas generation, customers take advantage of the knowledge, skill and expertise that Linde has gained by owning and operating over one thousand gas plants worldwide. The costs and risks of operating and maintaining the gas plants are left to the Linde experts. With a fleet of plants, Linde is best placed to maintain stocks of spare parts and provide the personnel with the proper technical experience and expertise. Gas production is Linde's specialty and we are able to pass cost savings along to our customers.

Global presence meets local support

Linde operates in over one hundred countries around the world, serving tens of thousands of customers in almost every market area imaginable. While sharing global expertise and knowledge, Linde still provides the highest quality services our customers have come to expect from their local account representatives. Our 50,000 employees mean that a Linde service expert is never far away, anywhere on the globe. And with over 100 years of history, customers can feel certain that Linde provides them with the best support for many years to come. Is Linde a global industrial gas company? Yes, and we are a local gas company almost everywhere around the globe.

Benefit from our expert applications know-how

Linde's knowledge of its customers' specific production processes enables them to reach their goals from reducing costs to improving quality to increasing production. ECOVAR® on-site supply solutions are especially well suited to achieve these objectives. Moreover, Linde has experts who can help customers benefit from applying gases to their processes and experts to ensure the lowest-cost supply of those gases.

For instance, Linde's know-how in the area of modified atmosphere packaging helps potato chip producers keep their products fresher by packaging them in nitrogen instead of air, leading to more sales over a larger sales region.

ECOVAR® supply of oxygen enables the glass industry to replace the traditional air-based combustion systems of their melt furnaces with oxy-fuel combustion. This creates considerable savings of investment costs since heavy flue gas heat recovery systems are no longer needed and a smaller heating surface area is required for the same production output. The main advantage is seen in reduced fuel consumption, which follows from the improved combustion efficiency of oxy-fuel technology. In most cases, this more than offsets the

cost of oxygen. Additionally, NOx emissions are reduced as are CO₂ emissions based on the reduced fuel usage.

In the steel industry, oxy-fuel combustion can be applied in re-heating furnaces of rolling mills. The main advantages are the same as for the glass industry, but here the specially developed REBOX® oxy-fuel solutions in reheating and its flameless burner technology provides additional environmental and quality-related advantages. REBOX® burners provide a diffuse, invisible and turbulent combustion which, due to lowered flame temperature, provides temperature uniformity in the furnace and reduced NO_x emissions. Thanks to the economical ECOVAR® oxygen supply, these advantages are achieved together with improved profitability of the steel production.

Photovoltaic manufacturers need a strong, reliable and knowledgeable partner, a single point of contact for the wide range of specialist materials used in the production process, and increasingly a supplier that can deliver independent technology solutions of its own, that contribute towards the industry-wide goal of attaining grid parity. Linde's commitment to clean energy and its global gas and engineering capabilities make it the ideal partner for PV manufacturing on any scale and in any location. For nitrogen and hydrogen supply to the photovoltaic industry, we have developed

standardised generator solutions which "grow with demand" and meet pressures and purities as required.

ECOVAR® is successfully deployed in the following industries and sectors:

- Electronics/semiconductors
- Photovoltaic (PV)
- Metallurgy/mining
- Chemicals and petrochemicals
- Glass
- Waste recycling and incineration
- Water treatment
- Food and beverages
- Pharmaceutical
- Refineries
- Heat treatment
- Iron and steel
- Non-ferrous
- Pulp and paper
- Manufacturing
- Energy
- Tire
- Metal fabrication



Benefit from our leading position.

Further advantages of using ECOVAR® on-site supply solutions.

Environmental sustainability for lasting success

Protection of the environment is a core value in Linde's corporate culture and it influences every decision we make. We bring "green" solutions to many industries through our gas application technologies. With ECOVAR®, we extend these "green" solutions to the gas we supply. On-site production of gases immediately eliminates the need for transport and distribution, saving energy and product losses. Less obviously, the energy-intensive process of liquefying gases for transport is eliminated by generating the gases directly on site. By selecting the most effective gas generation plant for each application, Linde further increases the overall effectiveness of applying ECOVAR®. Our research and development programmes ensure that Linde will continue to provide solutions with the lowest energy consumption and minimal environmental footprint.

Clear commitment to high safety standards

From the local service technicians to the scientists, engineers and designers to the office administrative staff to the highest-level board members, Linde's commitment to safety is unwavering. SHEQ (Safety, Health, Environment and Quality) is 100% of our behaviour 100% of the time. Every Linde employee is trained to provide safe installations and working environments for our facilities as well as our customers. ECOVAR® on-site supply solutions are monitored through telemetry, using Linde's remote operations centres around the world which are staffed with experts twenty-four hours per day, seven days per week. The maintenance of these on-site plants is carried out by professional Linde technicians who are trained in all aspects of the plant operation with a focus on safety. They are even trained to spot and report potential safety issues which might be beyond our formal scope of gas supply.



A broad portfolio of perfect solutions

With ECOVAR® on-site supply solutions, Linde offers standardised, modular plants that lead to lower gas costs by avoiding custom-detailed designs and by shop assembling, skid mounting and a maximum amount of containerisation. However, any benefit from standard, modular plants is quickly lost if the respective installation situation is overlooked. That is why Linde tries to offer the broadest portfolio of any industrial gas supplier.

Linde's on-site product line includes plants to produce oxygen, nitrogen and hydrogen, from the very smallest cabinet-style gas generators to plants which produce tons of gases per day. You can choose from a wide variety of sizes, along with designs which conserve energy usage any time the plant is producing less than its maximum capacity. No matter what the need, Linde has the right plant to meet it.

This even applies to the various technologies which can be employed to generate the gases. For instance, in the generation of oxygen and nitrogen, lower-purity gases, especially in smaller amounts, can most often be produced for the lowest costs using non-cryogenic adsorption plants. For higher purity needs and larger amounts, cryogenic distillation of air is the most effective means of producing gas. In the production of hydrogen, there are generally two technologies which are commonly applied. For smaller amounts and where natural gas supply is limited, the electrolysis of water is used. For larger amounts and especially where natural gas is available, steam methane reforming is commonly used.

Linde has installed and operates over one thousand of these plants from some of the smallest sizes to some of the largest.

Nitrogen solutions.

CRYOSS®-N

In these cryogenic gas generation plants, nitrogen is produced by fractional distillation of liquefied air using a cryogenic process. This process uses the different boiling points of the various constituents of air.

CRYOSS®-N HP/UP

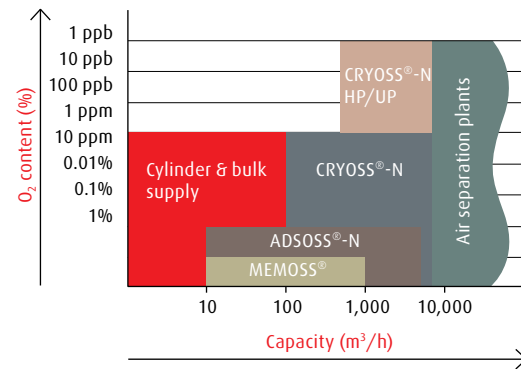
The same basic process is applied, but enhanced to remove impurities such as CO and H₂. This results in high and ultra-high nitrogen purity grades down to ppb levels.

ADSOSS®-N

ADSOSS®-N uses an adsorption-based carbon molecular sieve (CMS) to separate nitrogen from air. Under pressurised conditions, CMS adsorbs oxygen, carbon dioxide and water vapour, whereas the nitrogen passes through the sieve. The sieve is regenerated by simply relieving the pressure. ADSOSS®-N gas generation plants are designed with two adsorber vessels which alternate (as they become saturated) to ensure continuous operation. This is referred to as pressure swing adsorption (PSA).

MEMOSS®

Compressed air passes through extremely thin, long, hollow fibres, the walls of which act as semi-permeable membranes. Oxygen penetrates these walls relatively quickly, while nitrogen is generally retained within the hollow fibres until the desired purity is attained.



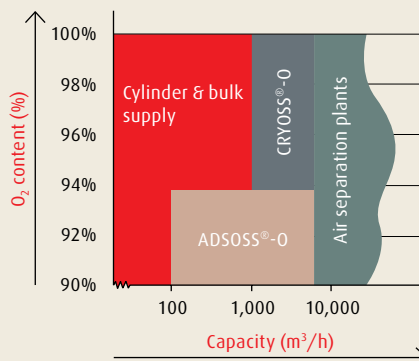
Oxygen solutions.

ADSOSS®-O

ADSOSS®-O gas generation plants extract oxygen by means of adsorption. Whereas nitrogen, carbon dioxide and water vapour are readily adsorbed by the surface of the special zeolites, oxygen easily passes through the material. The zeolite is cleaned by reducing the pressure, using vacuum blowers. ADSOSS®-O gas generation plants are typically designed with two cyclically-operated adsorber vessels to extract oxygen continuously. This is referred to as vacuum pressure swing adsorption (VPSA).

CRYOSS®-O

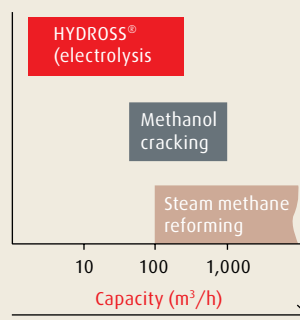
Oxygen can be generated by separating air with a cryogenic process. This solution can also be designed to produce a combination of oxygen and nitrogen.



Hydrogen solutions.

HYDROSS®

Depending on raw material costs (power, natural gas and methanol), Linde can offer the optimum hydrogen solution based on electrolysis of water, steam reforming of natural gas or cracking of methanol or other feedstocks. Both commercially pure and high-purity hydrogen can be produced on site, depending on the needs of the application.



Helping you make the right choice.

Supply solutions for every requirement.



Linde application and plant technology experts will work with the users' personnel to ensure the proper on-site solution is selected to meet the customers' production needs, now and in the future. With one of the world's leading plant supply engineering divisions in-house, Linde controls all the details of the installation, ensuring on-time, on-target gas supply. With this engineering capability and its broad spectrum of products, Linde can deliver an optimised solution for each individual case, even as the needs evolve into the future.

Various criteria must be carefully evaluated to ensure that the right decision is made.

Consumption profile

The product costs are lowest if the plant operates near full capacity without interruption. Reduced output increases specific costs by spreading fixed costs over a reduced yield. It is important to analyse the required consumption profile over time to determine whether a larger plant with a fast response time or a smaller plant with supplemental backup support is the most effective solution.

Purity

ECOVAR® on-site supply solutions are designed to deliver different levels of gas purity. Generally speaking, the lower the purity, the lower the product costs.

Pressure

The product pressure can also be an important cost factor. To avoid unnecessary costs, it is essential that the needed product pressure is accurately assessed and the plant designed accordingly.

Energy

The energy required for the gas production is one of the biggest production costs. The choice of plant must carefully balance gas needs against the costs of energy and capital costs.

Application

Many gas applications require specific gas production criteria and allow specific cost-saving optimisations. Linde's extensive gas applications expertise can assist in the proper selection of a gas generator solution.

Design determinants for your on-site plant

- Gas usage application
- Capacity of plant, backup unit and buffer vessel (if applicable)
- Availability and cost of utilities (energy, water, compressed air)
- Product purity and pressure
- Availability of space, authority requirements and other environmental concerns
- Development of future product needs

Linde leverages many years of experience in the field of on-site supply systems to help you make the right choice and to ensure that your gas supply contract works to your favour.

Services include:

- Analysis of demand profile in close collaboration with customer
- Detailed cost-efficiency and long-term viability analysis
- Evaluation of optimum supply concept, plant type, plant size and backup unit
- Gas application technology
- Support in all plant planning and engineering tasks
- Plant financing
- Supply, assembly and commissioning of the plant by skilled technicians
- Operation, maintenance and insurance of ECOVAR® on-site supply solutions
- Remote monitoring and control (with 24-hour surveillance) from a Linde centre

Benefits of ECOVAR®:

- Freedom to focus on core business
- Transparent overview of long-term costs
- No upfront investment costs
- No operating risk
- No personnel expenditure
- Zero maintenance and service effort
- No need to keep spare parts on stock

ECOVAR® is a cost-effective solution if you have:

- Long-term gas needs
- A relatively constant base load
- A high annual output (in terms of operating hours)



Linde works closely with you to ensure continuous supply.

Getting ahead through innovation.

With its innovative concepts, Linde is playing a pioneering role in the global market. As a technology leader, it is our task to constantly raise the bar. Traditionally driven by entrepreneurship, we are working steadily on new high-quality products and innovative processes.

Linde offers more. We create added value, clearly discernible competitive advantages, and greater profitability. Each concept is tailored specifically to meet our customers' requirements – offering standardised as well as customised solutions. This applies to all industries and all companies regardless of their size.

If you want to keep pace with tomorrow's competition, you need a partner by your side for whom top quality, process optimisation, and enhanced productivity are part of daily business. However, we define partnership not merely as being there for you but being with you. After all, joint activities form the core of commercial success.

Linde – ideas become solutions.

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